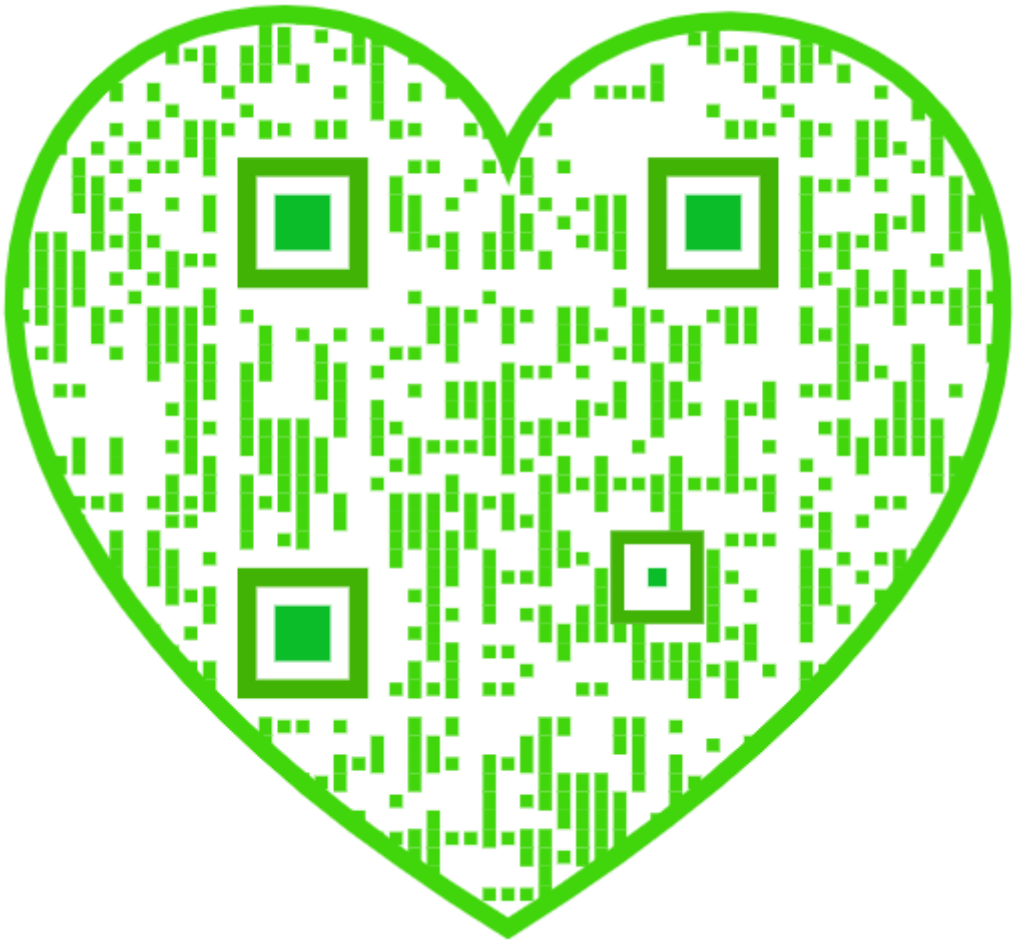
HEMP

(Cannabis sativa)

BOYCE

ORANGE JUDD COMPANY



CHINESE HEMP.

Growing for seed at Staten Island, New York.

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HEMP

(Cannabis sativa)

A PRACTICAL TREATISE ON
THE CULTURE OF HEMP FOR SEED AND FIBER
WITH A SKETCH OF THE HISTORY
AND NATURE OF THE HEMP PLANT

BY

S. S. BOYCE

Illustrated

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PREFACE

THERE should be no necessity for an apology or an exense for preparing a work upon hemp culture at this time. The hemp plant is the most widely diversified and, commercially and industrially, the most important plant in cultivation in Europe. It was among the first introduced into America, and one of the most extensive in cultivation among the colonists; and there is no good reason existing why it should not, but every reason why it should, today be among the first as the basis of another great and grand national industry, employing hundreds of millions of capital and hundreds of thousands of work-people.

Hemp fiber is acknowledged to be the standard fiber of the world; and, properly manipulated, it is adapted to a much wider and more diversified use than any other fiber known. The hemp plant is the most simple and the most widely adapted to cultivation in all climates, the most susceptible to the manipulations of chemical and mechanical processes, and the most universally adapted to the production of fine, strong fibers for the widest character of products, from coarse, strong cordage to threads and

yarns for the finest linens, lawns, and laces, and the culture and handling of the plant should long ago have become as familiar as household words to the American people in all its details.

But the industry, once flourishing and prosperous, has, by neglect and an over-competition from other less valuable but more easily manipulated materials, become a lost art to the most ready, most keenly alive people upon the globe, and some effort is necessary, and some pains of labor and expense, if it is to have a new existence at an early day, while the congestion of other industries, textile and agricultural, suggests that the time is opportune for an investigation into the nature of the plant, and its adaptability to the wide industrial uses to which it seems applicable.

The writer has given many years of study to a close, careful investigation of the hemp plant in its adaptability to cultivation in the soils and climatic conditions of the United States, its habits and conduct under various styles of cultivation, and also to the manipulation of the plant for obtaining a fiber best adapted to fine spinning, as well as to the conduct of the fiber in the processes of spinning and weaving. He speaks from a personal knowledge of all the facts and particulars, from his point of view, when he says that of all the fiber-bearing plants known to agriculture and commerce, hemp is most universally adapted to the production of fine,

soft, silky fibers, and to the establishment of one of the most important industries of the American people. Of all the industries of which the world has for centuries been conversant, that of hemp, and the spinning and weaving of its fibers into fine linen fabrics, is the last to obtain place among the American people, and it is still waiting the revivifying influences of modern industrial practices to take its place in the lead of their grand endeavors.

As in other American efforts to develop new industries, hemp and linen have long rested under the shadow of a persistent opposition from foreign influences, and with the continued sneers of "you can't, you can't, you can't," dinning perpetually, there has long been a feeling, and a want of confidence, as of some stupefying incubus which it seems hard to shake off, that only Russia, Austria, Italy, and France could raise hemp, and only England and Germany could manufacture it.

If this little work shall have the effect to call out the experience of others, and thus furnish a literature upon the subject of hemp culture to which the farmer may refer, the reward for the task will be sufficient. There is at present no record of experiments or of practical work of any definite value upon the subject extant. Quite the reverse, all old methods have been proved inadequate to the production of fine hemp fiber, while most of the directions for practice are diametrically antagonistic

to what is found best at every successive step of the industry. No complete determination of the nature, habit or needs of the hemp plant, in its twofold office of bearing seed and bearing fiber, has been made. No coöperation of the farmer and the manufacturer, through the inventor and chemist, for the production of a perfect fiber, is recorded; but the grower of hemp is left to grope in the dark as to what is required.

The tenor of this work may seem over-sanguine or over-enthusiastic, but no success ever attended any industry without the championing of some one who believed it practicable. The directions herein contained are in the interest of no individuals or patents, but are so plain that he who runs may read and inexpensively practice until he has proved the truth or falsity of all statements and claims made. The writer will welcome criticisms from whatever source, and receive and worship any other god, if shown to be more benignant toward the farmer's welfare.

S. S. BOYCE.

Tottenville, N. Y., 1900.

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HEMP

CHAPTER I

HISTORY OF THE HEMP PLANT

Hemp, *Cannabis sativa*, is the most important plant, commercially, and the one the most widely cultivated, in Europe. Adapted to cultivation in all climates, from the equator to a latitude of 60°, we find some variety of the plant coexistent with the progress of humanity from the earliest dawn of civilization in the far East, six thousand years ago, and still accompanying man through all the vicissitudes, incidents and exigencies of his march around the world

Whether the several varieties of the hemp plant now found growing wild or in cultivation in all parts of the world are all the children of one common mother-type, originating in the valleys of the Himalaya mountains, in Asia, the original characteristics of which are now lost to agriculture, or there was one variety or species indigenous to this early home of the Aryan people in central Asia, or another with the Touranians or Celts in central Europe, and from which the varieties have sprung and commingled, intermarried and their children scattered to the four winds of the earth, cannot now be deter-

mined. A coarse hempen cloth has been found among the remains of the Cave-Dwellers and earliest inhabitants of Europe, by whom it may have been made at a time as remote as when the Pharaohs were laying the foundation stones of the pyramids, six thousand years ago. Herodotus states that the Scythians cultivated hemp in the valley of the Volga four thousand years ago.

Whether the seed from the one wild parent plant has been modified by the soils and climatic conditions of centuries of existence, under varying circumstances, irregular, uncertain, often unfriendly, and become a more or less tractable, more or less useful plant, its habit changed to one of shorter growth, earlier and more prolific of seed, as found in the higher latitudes, or to the plant of tall, slender and graceful character, as found in the warmer and more moist climates, cannot be ascertained. Certain it is that some variety of the plant has accompanied humanity in its migrations, and found lodging place in the highways and byways of man's industries, ministering to his wants in response to, and accordingly as, his care has been friendly and considerate.

The origin of the English word hemp is as obscure as that of the plant itself. The earliest name for the plant is the Sanscrit *sana*, a hollow reed-like plant or cane. Corresponding to this is the Persian *canna* and *kannap*, hence the Arabian word *cannab*, a small reed or cane. Greek *kanna*, a reed and anything made from it; also *kannabis* and *kannabos*. Latin *cannabis*, from canna, a reed or cane; also a tube or small vessel. Italian *cannapa;* also *canna*, a reed, cane, pipe, hollow tube or meas-

uring stick. French *chañvre*, *canevas*, hemp and a cloth made from hemp; also *canne*, a cane or reed, hence *cantare*, a voice through the reeds; and the many words of similar derivation. In French, as is quite common, the c and k become ch.

We find no exactly corresponding word in Anglo-Saxon, or the German or Celtic tongues. There seems to have been a division of names by those cultivating the plant, in the migrations from the far East, one branch passing to the south of the Black Sea and the other to the north, and with the changes in the sounds of letters and the word formation common to the language, the Greek k becoming c in Latin, ch in French, and to the north of the Black Sea the k and c becoming h. The words *hanapus* and *hanaperium* in Old Latin, *hanap* in Old French, and *hanaf* in Old High German, a vase, bowl or basket, correspond to the English hamper and hanaper, and which are the same in Swedish, a hempen bag or wicker basket, while Latin *harundo* is also a reed or cane, taller than *cannabis*. The word for hemp in Anglo-Saxon is *henep*, Dutch *hennep* or *kennep*, Old High German *hanaf*, and Swedish *hampa;* Polish *konopj*, and Russian *konoplia*. The word for canvas is the same as for hemp in Latin, Greek, Italian and French, while in all English *canvas* meant a cloth for straining. The word *cannabis* is the Latin for the wild hemp plant, while *Cannabis sativa* is the plant in cultivation. Pott's "Etymologische Forschungen," and Winning's "Comparative Philology" give the word hemp as of Slavonic origin.

Beyond the cultivation of hemp for its fiber for making garments and household linens by a large

part of the people of northern Europe and Asia, the Arabians cultivated a variety of the wild plant, growing but three to five feet, for the resinous gum, *hashish*, or *bhang* or *banque*, an intoxicating drug. Æschylus also states that it was burned and used for vapor baths, while Herodotus says the Scythians were intoxicated by inhaling the fumes of the burning seed. The leaf, when dried and smoked, is also said to alleviate pain, producing a narcotic, intoxicating effect, increasing the appetite, and giving rise to mental cheerfulness. When the resinous gum which exudes from the plant is taken internally in small doses it produces hilarity, and the patient soon becomes insensible; but when recovering perceives no apparent ill effects to mind or body. *Gunjah* is an East Indian word for the dried hemp foliage, which was smoked for its intoxicating effects. The seed is used to feed birds and fowls, and to make oil for paints and for making soap.

The name hemp is also given to the commercial fibers of a great number of plants, especially to those of the agave or century plant, *Agave Americana*, the sisal of commerce, and growing in Central America. Also to the fiber of the wild plantain, or *musa* (Manila hemp), growing in the Philippines, neither of which are true fibers, nor are they capable of subdivision for spinning into fine numbers. Jute, *corchorus*, was once called India hemp. There is also a Sunn hemp, the *Crotalaria juncea*. A species of hibiscus, *H. cannabinus*, growing in India, is also called hemp, but the fiber is inferior even to jute. New Zealand flax, *Phormium tenax*, is often called hemp, as are a great

number of other plants of less importance; but, aside from the true hemp, *cannabis*, flax, *linum*, and ramie, *Bæhmeria*, there are no true vegetable fibers adapted to fine spinning at present known to commerce.

The variety of hemp best adapted to the production of a fine, soft fiber, and that growing the tallest, the most rapidly, and the longest between leaf joints, comes from the wild Indo-China plant, *Cannabis Indica* and *C. sericeus*, also called *C. gigantea*. It is later in maturing seed, however, and, bearing but little seed, is liable to be crowded out by the more prolific earlier varieties (Fig. 2). With favorable conditions of soil and moisture, the Indo-China variety grows to a hight of fifteen to seventeen feet in a latitude of 40° in the United States, and up to twenty to twenty-five feet farther south, in from ninety to one hundred days, according to mean temperature and time of planting.

A variety long known in Turkey as Smyrna hemp, and in Italy as Italian hemp, *cannapa*, the seed of which is also imported into France for growing the taller French varieties, is earlier, more inclined to branching and more prolific of seed, and rarely grows above thirteen feet in hight, even under the most favorable conditions of soil and climate.

Another variety also found in Italy and called *Cannapa picola*, or small hemp, grows four to six feet, while the common hemp cultivated in Europe grows five to seven feet tall, and seems to be a cross or degenerate from the former varieties, and perhaps from mixing with the Hungarian and Russian varieties.

Fig. 2. Chinese Hemp.

Stalks of Hemp grown for fiber in the center.

This lower-growing variety is often planted much thicker, and furnishes a plant in character and habit intermediate in size and appearance between flax and hemp.

The wild Hungarian and Russian varieties seem quite a distinct type, differing considerably in general appearance, in cultivation, from the others, and also partaking somewhat of all the other European varieties, being quite irregular in habit and in hight of stalk, and with a coarser, not so readily manipulated, fibrous material.

The hemp plant is found growing wild, as if indigenous to all parts of the world, especially in the northern portions of Europe and Asia, and, in the different latitudes, partaking to a considerable extent of the nature of the plant in cultivation near by, as if the wild plant had escaped from cultivation or the cultivated plant had been recovered from its wild state and, by cultivation, made to assume a character more in keeping with the wants of the cultivator. In its struggles for existence the wild plant presents many differing characteristics of more or less interest to the botanist.

The general effect of cultivation upon hemp, as of all other plants, is to restore it from the irregularity of unfriendly conditions of soil and the overcrowding of its own or other foliage, and to give it a tendency to a higher production of seed, instead of a large proportion of weed or stalk. This result is apparent in almost all farm crops, where the purpose is to seed thinly and to keep out weeds, so that the production of fruit may be as great as possible, instead of a tall stalk or shoot. In cotton the aim is especially to prepare the soil in a way

that the tap-root may early strike hard-pan, and thus force the plant up to fruit, while fertilizers are applied with special reference to fruit rather than to a tall-growing plant. With sugar cane, which does not flower in semi-tropical climates, the purpose is the reverse: to grow as tall and large a cane as possible. The same object is desired with hemp, by the application of nitrogen to produce a tall stalk, but with a thick seeding of the ground to prevent the growing of large stalks.

Hemp is the king of fiber-bearing plants,—the standard by which all other fibers are measured; while none but silk is of a finer character, and none other is so universally adapted to a wide soil and climatic conditions and the rude arts of the semi-barbarous husbandman, and the primitive methods and practices attending the preparation of its fiber; yet none is more amenable to the care of exact culture, nor better rewards the skill of fine-art methods of fiber-manipulation. No plant is more susceptible to the processes of producing a fine, white, soft and silky fiber, and there is not one to take its place in the wide and diversified area of its culture and manufacture.

Besides its adaptability to cultivation in all climates, it may be grown continuously upon the same soil with but a minimum application of manures, provided the refuse is returned to the land. According to the methods of manipulation to obtain the fiber, it may be used for the strongest and coarsest cordages or to produce the finest linens. In the colder latitudes, while the fiber is coarser, the medicinal qualities are milder, less pronounced, and less effective. The hot, moist climate of the tropics

is exceedingly well adapted to the rapid growth so favorable to the production of an abundance of fine fiber, while the plant yields substances said to be very powerful in their narcotic and intoxicating effects.

CHAPTER II

BOTANY AND CHEMICAL COMPOSITION OF THE HEMP PLANT

Hemp is an exogenous, hardy annual plant, capable of withstanding a freezing temperature without damage. It grows luxuriantly in proportion to fertility, warmth and moisture, from a hight of three to five and seven to eight feet, according to variety, in latitudes of 50° to 60°, increasing in hight some two to five feet for each ten degrees of latitude, up to a hight of twenty to twenty-five feet for the Indo-China variety in the tropics.

Hemp may be planted at the same time as oats, spring wheat or rye, as soon as the ground can be made ready, and south of a latitude of 35° at any time during the year.

In latitudes south of 40°, with care, two crops a year of the early varieties may be readily grown; or a crop of hemp and a crop of peas to keep up the fertility of the soil. Under favorable conditions, the growth of hemp is very rapid, from two to three feet the first thirty days, and three to ten feet the next thirty, according to variety, climate, character of fertilizers, condition of soil, and supply of moisture, being ready to harvest for fiber in eighty to ninety days, the seed ripening in forty to fifty days thereafter, according to variety. With an abundance of moisture, humus, and nitrogen from

decaying animal matter in the soil, seed-hemp of the Indo-China variety has been seen growing in Florida twelve months from the time of sowing the seed, twenty-five feet tall and six inches in diameter six inches from the ground.

FIG. 3. CHINESE HEMP. Male and female plants.

Hemp is dicœcious, the male and female stalks being essentially different in habit and in the peculiarity of fiber-production. Hemp belongs to the family *Urticaceæ* (Nettles), and the tribe *Cannabineæ*. A male plant is seen to the left in Fig. 3, and a female plant to the right.

Like flax and ramie, the two other true fiber-bearing plants, hemp has its fiber in a heavy bark

or rind, firmly massed and bound together by a resinous gum of great consistency, not soluble in boiling water, but readily yielding to putrefactive fermentation and to alkaline and saponaceous solvents, yielding a soft, white, silky fiber adapted to the production of the finest threads, linens, lawns and cambrics. Like the pure fiber of all plants, its natural color is white, and it is only discolored by the imperfect practices used in cleansing it from its gum and extraneous surroundings

In cultivation hemp has a long, white, fibrous, tapered root, deeply penetrating the soil, when made mellow by deep tillage, in search of the special plant-food and the large amount of moisture it requires. Hemp absorbs a large amount of nitrogen from the soil, and if dry the roots penetrate to a great depth; while if an over-abundance of moisture is given, it spreads out numerous roots near the surface, accommodating itself to existing conditions with great facility and regularity.

The hemp stalk is straight and ramified, hollow at times, according to the presence of peculiar manures which force a rapid growth, or nearly solid in hard and impoverished soils, and bears long branches at short, regularly spaced intervals when growing isolated, but only leaves at the joints ten to fifteen inches apart if the ground is rich and the plant growing rapidly. When sown thickly and the plant is growing fast, these leaves fall early as the growth proceeds, and the heavy top foliage shades the plants, producing a smooth, slender stalk of great beauty, and with a cortex conditioned to furnish a smooth, soft, silky fiber for fine spinning.

A part of the fibers, starting from the root, end at each successive leaf-joint, hence the amount of fiber grows less towards the top; thus the advantage of thick-seeding and of having the plant grow rapidly, so as to make the leaf-joints as far apart as possible. The leaves and branches grow opposite each other, the digitate leaves consisting of seven to nine, sometimes eleven lanceolate, coarsely serrated leaflets.

In male hemp the flowers are panicled, axillary and terminate. They have five nearly equal sepals, five drooping stamens, and oblong, tetragonal anthers disposed, ordinarily, in light green clusters. When mature, in some ten days to two weeks from time of blossoming, these turn yellow and, if not harvested, the plant dies and rapidly loses its "nature."

Female hemp has sessile axillary flowers, too small to be noticed excepting by close observation. The calyx is elongated and extended on but one side. The crowns are ovary-bearing, with two styles and their stigmas. A small, round capsule with two valves contains one little grain of seed, at first white, and then the covering green, turning to brown. The seeds are gray-striped in some varieties, while in others they are of a dull color, and when ripe sometimes nearly black.

The finest fiber known to the manufacturer's art is that of the best water-retted hemp frequently cleansed by being carefully "boiled off," to free it from the resinous, gummy matters which unite the fibers, and after it has been broken and the woody matter shaken out. In all manufactures of hemp and flax the yarns or fabrics are boiled off in alka-

line solutions, to free them from the gum and other extraneous matters, if the fiber itself has not been previously so treated. When so cleansed and subdivided, a mass of fine, soft *fibrillæ* is presented almost rivaling silk in luster and spinning qualities.

The chemical composition of hemp presents some features peculiar to the plant. Grown for fiber, there is nothing in the product removed from the hemp of much special value, compared with plants grown for seed. In cotton and corn and other grains the seeds carry away very large quantities of plant-food. Plants which do not produce or ripen seed, like hemp and sugar cane, require different elements, and for that reason there is no analysis of hemp on record by which to make an exact comparison with the plant as grown for fiber. The tendency of all cultivation is to produce fruit at the expense of weed. For fibers the reverse is the aim.

With the seed and plant complete, an analysis of the hemp and flax plants gives the following composition:

	Hemp	*Flax*
Carbon	38.94	38.72
Hydrogen	6.06	7.33
Nitrogen	1.74	.56
Oxygen	48.72	48.39
Ashes	4.54	5.00
Total	100.00	100.00

The ashes of the hemp and flax plants give the following per cents:

	Hemp	*Flax*
Potash	7.48	20.32
Soda	.72	2.07
Lime	42.05	19.88
Chloride of sodium	....	9.27
Magnesia	4.88	4.05
Alumina	.37	....
Oxide of iron	....	2.83
Silica	6.75	12.80
Phosphoric acid	3.22	10.24
Sulphuric acid	1.10	7.13
Chlorine	1.53	....
Carbonic acid	31.90	10 72
Total	100.00	99.31

These include both seed and stalk. The ashes of the hemp-seed and flax-seed show:

	Hemp-seed	*Flax-seed*
Potash	20.81	25.90
Soda	.64	1.30
Lime	25.57	26.00
Magnesia	.96	.20
Peroxyde of iron	.74	3.70
Phosphoric acid	35.52	40.10
Sulphate of lime	.18	1.00
Chlorine	....	.90
Chloride of sodium	.09	....
Silicic acid	13.48	....
Silica	....	.90
Carbon	6.19	....
Total	104.18	100.00

The leaves of the hemp plant contain:

Carbon	40.50
Hydrogen	5.98
Nitrogen	1.82
Oxygen	29.70
Ashes	22.00
Total	100.00

The fibers of both these plants contain but very little of plant-food. Where grown for fiber, as is hemp, and the refuse returned to the soil, it literally takes nothing away from the land; while in fact it furnishes sufficient plant-food to keep the soil in nearly perfect condition. The following will show comparative demands for plant-foods:

	Nitrogen	*Potash*	*Lime*	*Phos. Acid*
Hemp plant	1.74	.34	1.90	.15
Hemp-seed	2.61	.97	....	1.75
Flax plant	.59	.49	.61	.55
Flax-seed	3.28	1.04	....	1.30
Cotton plant	1.90	1.50	1.60	.30
Cotton-seed	3.00	1.20	.20	1.00
Pea-vines	2.07	1.45	1.50	.52
Cowpeas	3.97	1.48	....	.94

The amount of fertilizing elements required to produce the plants for one hundred pounds of cotton lint, and of flax and hemp fibers, is given by the Year Book of the U. S. Dept. of Agriculture for 1897, as follows:

	Weight of plant (in pounds) for 100 pounds of fiber	FERTILIZING ELEMENTS		
		Nitrogen	*Potash*	*Phos. Acid*
Cotton	747	20.71	13.06	8.17
Flax	687	19.37	7.29	6.76
Hemp	597	6.27	10.13	3.32

This shows that hemp requires less than one-third of the nitrogen and less than one-half of the phosphoric acid that does cotton, which requires 41.94 pounds of fertilizers, flax 33.42 pounds, and hemp but 19.72 pounds.

As an acre of cotton should give a yield of 500 pounds of lint, the yield of dry stalks, with bolls complete, should be 3,735 pounds, and the amount

of nitrogen used, 103.55 pounds, with 65.30 pounds of potash and 40.85 pounds of phosphoric acid. An acre of flax should yield 350 pounds of fiber, and the whole weight of growth should be 2,405 pounds, requiring 67.79 pounds of nitrogen, 25.51 pounds of potash, and 23.66 pounds of phosphoric acid. The average yield of hemp fiber per acre under similar conditions would be 1,500 pounds, giving a yield of 8,955 pounds of growth, and the nitrogen used would be 94.05 pounds, potash 151.95 pounds, and phosphoric acid 49.80 pounds. The value of the product of an acre of each of these three plants would be, at present prices, cotton $30 (seed and lint $45), flax $35 (seed and fiber $45), and hemp $105. The cost of the culture of each crop would not materially differ. The cost of the chemical fertilizers, if they had to be purchased, would be, cotton $25, flax $14, and hemp $24; but as a large part of these plants may be returned to the soil, it is only necessary to see that the soil upon which the crops are to be grown is at first fully supplied with these plant-foods. The lint of cotton and fibers of hemp and flax practically carry away nothing from the soil. The seeds of these plants, however, represent a certain cash outlay for manures. The analysis of 100 pounds of cotton-seed, flax-seed and hemp-seed show:

	Nitrogen	*Potash*	*Phos. Acid*
Cotton-seed	3.00	1.20	1.00
Fax-seed	3.28	1.04	1.30
Hemp-seed	2.61	.97	1.75

This shows 100 pounds of cotton-seed to be worth 50 cents as manure for these plant-foods alone; 100 pounds of flax-seed to be worth 68 cents, and 100

pounds of hemp-seed to be worth 50 cents. So that at the present prices of these seeds, the cotton-seed should be used as a fertilizer, and the flax- and hemp-seeds sold.

A comparative analysis of the ashes of hemp-, flax- and cotton-seed show:

	Hemp-seed	*Flax-seed*	*Cotton-seed*
Potash	21.67	25.90	37.45
Lime	26.63	26.00	4.44
Phos. acid	34.96	40 10	34.90
Silex	14.04	.90	4.35

The hemp plant is not grown for both seed and fiber, so the fertilizers of the seed are saved: while if cotton-seed is returned to the soil its fertility would be preserved.

Analyses of the steep-water, in which hemp and flax have been retted, showed the following comparison:

	Hemp-steep	*Flax-steep*
Carbon	55.66	53.93
Hydrogen	8.21	7.31
Nitrogen	6.45	3.86
Oxygen	29.68	35.90
Total	100.00	100.00

The ashes of hemp-steep were 49.20 per cent, and of flax 42.01 per cent. As this steeping process, or any other dissolving of the resinous matters from the fiber, takes away almost everything which the plant takes from the soil, it is easily seen how valuable a fertilizer is the refuse of these plants. After the hemp stalk has been peeled and the fibrous material removed, an analysis of the stalk alone showed;

Carbon	56.80
Hydrogen	6.48
Nitrogen	.43
Oxygen	34.52
Ashes	1.77
Total	100.00

The ashes contain but a trace of alkali, and the nitrogen is in very small quantity; hence the burning of the woody matter as fuel to run the machinery necessitates but a trifling loss.

In all these analyses, however, the fact remains that, on account of the lack of exact botanical determination, a great deal still remains as an exceedingly interesting study for the chemist. An analysis of hemp must differ from cotton in the fact that when growing hemp for fiber, a tall stalk, and no seed product, is required, while with cotton, as with most other plants but sugar cane, a short stalk, with much fruiting or seeding, is necessary; hence the determination of what special plant-foods are necessary to produce hemp plants with seed, does not equally apply to the growth of a hemp plant without seed. In this connection, the results of some experiments now making show that where the soil contains a large amount of humus and decaying animal foods, furnishing an abundance of nitrogen, the hemp plant grows very much faster and taller. If two crops a year are to be grown, a different manurial condition would be required than if the whole season were to be given to the production of one crop. With an abundance of nitrogen and moisture, the nitrogen dominates the growth, and the hemp stalk is far more hollow, the growth

more rapid, and the distance between leaf-joints much greater. In 1863 Congress appointed a commission to investigate the cultivation of hemp and flax, but its labors were confined to the study of what practices were already in existence; and while it found that the product of hemp in the United States in 1860 was over 87,000 tons, the work was irregular, and the report too incomplete to be of value to the hemp grower. Numerous publications have since been issued by the Department detailing foreign practices, but in a manner too superficial to materially aid the farmer.

CHAPTER III

CULTURE OF HEMP IN EUROPE

FEW of the primitive practices, remnants of oldtime methods, still obtaining with the proprietors of small plots of land, who still grow hemp as a branch of their family employment in the Old World, present examples for copying, or by which to profit, in the more extensive practices in America, where ranches square miles in extent take the place of square acres in Europe, and labor-saving appliances that of hand labor. France, situated in the center of European industry, is a highly tense and concentrated industrial country, with a territory one-fifth less in extent than the state of Texas. She, nevertheless, has taken the lead in all the arts, coarse and fine, of agricultural production, and in textile design and industrial advancement; but in a space so confined there has not been the opportunity to work out upon an extended scale the lessons she has so exactly learned.

Three-fourths of the agricultural acreage of France is divided up into small holdings, averaging less than six acres each, and upon these small tracts of land, adjoining the dwellings, the hemp industry of France first came into prominence, dating back to the beginning of the seventeenth century, when the people cultivated the hemp, prepared the fiber, and by hand labor spun and wove it into cloth for

canvas, or for garments, and into linens for household use. At the revocation of the Edict of Nantes the King of France sent out to the rest of the world the prolific seed of the world's intelligence,—liberty and industrial progress, and the culture and manufacture of hemp was one of the best. In a few instances more modern methods have prevailed, and from these some knowledge may be gleaned by which to verify the claims for better methods in American practice, and to suggest further improvements. The *Encyclopédie Chimique*, Paris, 1890, gives some account of the later practices, with instructions for hemp cultivation and for the preparation of hemp fiber as at present practiced in Europe, from which we make selections.

Researches among the remains of the semi-barbarous people first inhabiting France show that the production of hemp was among the earliest of the arts, and furnished the materials for garments and household linens continually. Hemp was of the simplest of cultivation, and its fiber product most easily adapted to the necessities of the people in their everyday tasks. As early as the beginning of the seventeenth century we find the industry systematically established among the small farmers, who possessed small plots of land adjoining their dwellings, where they sowed their hemp every year, after having given the utmost care and attention to the fertilization, deep tillage and careful preparation of the soil for that purpose.

The ingenuity and close application of the people of that country early gave a high character to the fibers and household linens produced, and both the production and quality have steadily increased, until

France annually produces over 70,000 tons of raw hemp fiber, and annually adds some 25,000 tons more by importation to supply her manufactories. Over 250 mills are engaged in its manufacture. M. Charpentier asserts that, contrary to most plants, hemp may be grown continually upon the same soil without any material deterioration, and the plant and fiber are always fine when the cultivation is carried on with care and intelligence. This cultivation of hemp in the small household hemp fields, and in which the cultivator spared nothing, served as a grand school for the exact culture and preparation of hemp fiber by making known and appreciated the richness of the fiber of this textile plant and its wide adaptation to the production of fine fabrics for garments and household use. Besides this cultivation adapted to the small households, many parts of France now cultivate hemp upon a large scale, with a systematic rotation of crops, and with great care in the preparation of the fiber.

Up to the end of the eighteenth century, and before the invention of machine-spinning by Ray, in 1826 (Ray was a French manufacturer at that time), the hemp produced in Picardy and Alsace was chiefly used for coarse products of cordage and fish-nets, while that of Dauphiné and Limoges served partly to supply the hand-spinners and weavers of the mountains of the Isère and Puy de Dôme, whose fine fabrics so long had a great reputation in the south of France. The plains of Grenoble produced hemp of a remarkable fineness, which supplied the numerous spinners of Dauphiné, whose products contributed so much to the great reputation of the fine linens of Voiron. Today these plains, so well

adapted and so well situated in the shelter of the Alps, enjoying a damp and warm climate, possessing all the natural elements for producing a fine hemp plant, still produce good hemp. Limoges, which unites with the natural elements of a climate warm and moist during the time of the growth of the hemp plant a rich, deep soil, easily cultivated, has been particularly favored in the culture of hemp.

Carried on intelligently, hemp culture is one of the most productive industries known. With care one can easily obtain 1,000 to 1,200 pounds per acre of a fine fiber, ready to spin, besides twenty bushels of oleaginous seed. The parts of France where hemp now gives the best returns are Anjou, Sarthe, Picardy, Touraine, Maine and Normandy.

The writer in the *Encyclopédie Chimique* gives directions for the cultivation of hemp, and states that the plant is now the most widespread and important commercial plant of Europe. This is consequent not only upon the simplicity of its cultivation and the possibility of replanting indefinitely upon the same land, but also and especially upon a principle of oldtime husbandry which led the cultivator of the soil to produce all he consumed. Thanks to its short period of growth, hemp can be cultivated in all latitudes on the continent of Europe, from the neighborhood of Archangel to the plains of Granada.

As a complete crop in European farming, however, we would like to see generally adopted the improved process of retting, by which there would be a more systematic cleansing and preparation of the fiber, and a complete return to the soil of the great amount of nitrogenous and mineral matters

contained in the stalks and leaves of the plants, which are now lost in the steep-water. The fibers of hemp are stronger, but by the present imperfect methods of retting not so easily subdivided, as flax. This the new and improved methods of retting should rectify.

The art of producing a fine hemp fiber consists, first, in a careful noting of the proper time of sowing the seed, and that the soil be fertile and deeply tilled, that the hemp may grow rapidly. The seed should be perfect, so that it may all sprout at once, and sown in sufficient quantity that the stalks be near enough together to prevent branching, and that the stalks do not grow too large, and also to perfectly shade the ground.

Hemp having a long tap-root, the soil must be deeply tilled and made mellow, to give it free access to the humus and to obtain moisture, and to absorb its proper plant-foods during its period of growth. Deep fall plowing is also desirable and advantageous, to turn up the hard earth and expose it to the action of the frost and snows of winter, making the soil more permeable to the atmospheric influences. Early spring plowing is also recommended, to prevent the soil from hardening before the final stirring at the time of seeding, and because the soil cannot be too thoroughly pulverized and prepared for the free feeding of the fine rootlets of the plant. To see that the soil is mellow and friable is one of the most important rules to be observed.

The amount of manures should be liberal, and be spread upon the ground as early in winter as possible, that the rains may soak the nutritive matters into the soil. If we wish to use poudrette or

guano, these should be applied after the last plowing, only a short time before planting. These fertilizers produce a more immediate effect and insure a more rapid and uniform germinating of the seed.

The seed is a very important element in obtaining fine plants of even hight, and should be selected with great care. To be good, the seed should be gray in color, bright, plump and heavy. When the kernels are crushed between the teeth they should leave a pronounced nutty taste. The seeds which remain white are abortive, and will not germinate, while those of a greenish color are unripe and germinate slowly, the plants from them lacking strength, and are smothered by those of more vigorous growth. The black seeds have undergone fermentation, have a rancid taste, and their presence indicates want of care in drying at the time of harvesting, or a fraudulent mixture of old seed.

In Anjou the farmers usually purchase their seed from cultivators in Touraine, who make a specialty of raising seed. These latter generally obtain their seed from the valley of Carmagnola and Piedmont, Italy. This seed produces, the first year of sowing, a new seed which is called in commerce *fils de Piemont* (sons of Piedmont). The product from this last seed is designated by the name of "grandsons of Piedmont," and from this last seed the best fiber is thought to be obtained.

The time of sowing should vary with climate, soil and conditions of the season. Seed should be sown broadcast, and, if possible, just after a rain, toward the end of April in the latitude of Paris.*

*Paris is warmer than the same latitude in the United States, and corresponds in mean temperature to New York city, Indianapolis and Omaha.

When we wish to obtain an especially fine, high-priced fiber, the seed is sown more thickly upon a warm, moist and fertile soil, so that the plants will grow in one long shoot with few leaf-joints, and if there has been care in all the work of preparation the hemp plants will all grow of the same uniform size and hight, so that the interlacing leaves will shut out the sunlight and the air from the stalks and their fibrous coverings. This protection to the stalks of the plant, seconded by a vigorous growth, is one of the most powerful elements in producing a fiber bast rich in soft, fine, silky fibers, fit to spin into fine, strong yarns, and especially adapted to the production of fine linen, laces or other textile fabrics for garments and household uses.

The wind and the sudden changes of hot and cold atmospheric currents have a remarkable influence upon textile plants in effecting changes in their fibrous nutrients, hardening the gum resin which binds the fibers together, and rendering them coarse and "harsky." It is, therefore, easily seen that when growth takes place under the natural shelter of the leaves, as if in the mild, soft atmosphere of a conservatory, the vegetation is protected against the ill effect of any sudden changes of temperature, while the mellowed air which surrounds the stalks preserves their warmth and moisture in a manner and condition very essential to the production of soft, silky fibers. If the soil is fertile, warm and moist, the plants will spring up quickly and uniformly, and if all the directions here given have been observed, the product will be a highly satisfactory one.

Weeding hemp is not necessary. The plant is

not injured by weeds, excepting the tie-vine or wild morning-glory, a weed which should be exterminated from every plantation, no matter with what trouble.

We have said that hemp can be raised for many years upon the same land, because the fertilizers applied easily restore in most part the elements which hemp takes from the soil. However, there usually comes a time when, from neglect to completely recuperate the conditions of the soil by rotation and the application of manures, the condition becomes inimical to a luxuriant growth of hemp. The soil has become exhausted, and a parasitic plant of the genus *Orobanche*, chokeweed or broom-rape, fastens upon the root of the hemp plant in such a manner and in such numbers as to sap its vitality. By the presence of this weed we know that the soil is becoming "hemp sick," or exhausted of the special characteristics from a too long and a too steady drain in the cultivation of hemp, with a neglect of rotation or of a proper restoration; and the field must be turned to other crops.

Insects rarely attack the hemp; in fact, it is in its nature, peculiar odor and medicinal composition a preservation against the attacks of insects upon other plants growing near it. The larva of the death's-head moth, *Acherontia atropos*, at times bores the hemp stalk for a home.

In harvesting hemp, if we wish a very fine, high-priced fiber, the harvesting is done before the seed is ripe. If the hemp is left growing too long the male stalks languish, while the fiber upon the female, or seed-bearing stalks, becomes coarse and

hard; while if the hemp is harvested too early, and before the male has blossomed, the fiber will be very fine, but too soft.

In cultivation upon a small scale, the hemp is generally harvested in two parts. The male is pulled when it has shed its pollen, and the female after the seed has ripened. In this way the male gives a fine fiber, while that of the female is harder and only adapted to coarser work, but the seed is saved.

In Alsace the hemp is all pulled at one time, just as the seed is forming; but it is allowed to ripen afterwards in the sun. In this way the fiber becomes coarser and only adapted to cordage, but some seed is saved. In Picardy there is also but one harvesting, after the seed is formed. In most other places the hemp is gathered early and while the male is in full blossom, and no attention is paid to saving the seed, while a finer and softer and more valuable fiber is thus obtained, worth more than both seed and fiber as obtained by the other methods.

In whatever way the hemp is harvested, it is at once bound up in small sheaves when pulled, and stood up to dry, and then shocked. The seed is beaten out, the tops and roots cut off, to even it in length, by a sharp cutter. Or after the roots are cut off the hemp is stood up, bundle by bundle, and the taller stalks pulled out; or the bundles are laid upon the floor, butts to the wall, and weighted, and the long stalks pulled out. To save the seed, care is taken to see that it is perfectly dry, that it may not heat and ferment.

In very much of the hemp industry in France,

still confined to small acreages, the work is irregular in many respects. Full advantage cannot be taken of labor-saving appliances or the more economical modern processes, as when conducted upon an extended scale, nor can any attempt be made at classification, as the small producer must dispose of his product to the middleman for classification, finishing and marketing, thus losing a very large percentage of the profits which would be his under the circumstances of working an extended acreage.

A considerable part of the hemp grown in France is still retted by the antiquated method of spreading it upon the ground for the destructive action of the elements, and the product is a very coarse, dark-colored fiber, almost worthless for any modern methods of manufacture. When not thus spread upon the ground the retting is largely done in pools of stagnant water, either natural or artificially constructed by being dug in the ground at any convenient place, of an extent large enough to accommodate the one to five acres of hemp grown. For this a pool of a size to hold two to ten or twelve tons of hemp will be required, although these pools are usually four or five feet deep, ten to twelve feet long, and five to eight feet wide. The sheaves of hemp are packed with the butts alternately one way and the other, until the pit is full, or all the hemp is used up. It is then weighted down by stones and the pit filled with water. The same water may be used over several times, until all the hemp is steeped. The method is wasteful, the steep-water not being utilized, while the stench at the retting season of many of these stagnant pits is something unbearable. Nor is the product

of much greater value than by the more primitive method of spreading the hemp upon the ground.

The best results are obtained when hemp is grown upon a large scale and the hemp retted by being steeped in running water. Quite often the hemp is placed in crates holding a ton or more of stalks, and then weights of stones placed upon them to hold the hemp under water for five to eight days, according to the temperature of the water.

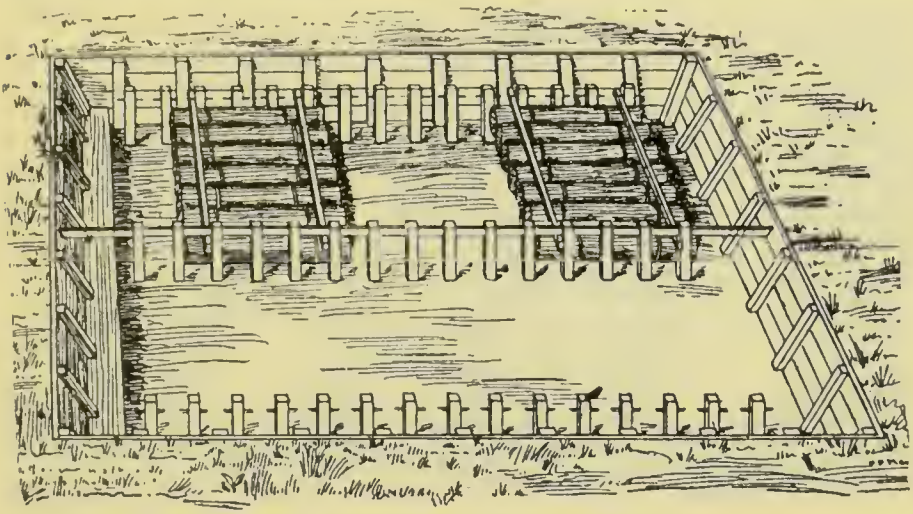

Fig. 4. Stake Retting Pit.

Part of the more modern practice is to dig pools five to seven feet deep, which will hold ten to twenty-five tons of hemp, and into which, if the pits are so situated, a small stream of water may be conducted and the overflow allowed to run out upon the land as a fertilizer. The illustration, Fig. 4, shows a pit made of upright posts and cross bars for holding down the hemp, and in Fig. 5 is seen a pit in which stones are used to weight and hold down the stalks when in place.

A later practice is to place the hemp in the

water for four to five days and then take it out and dry it, returning it again to the retting- or steeping-place for from four to six days more. This gives a better fiber, of a creamy white color, and a more evenly retted product. Or, after first being in the water for five to six days the hemp is dried, and when afterwards broken and the hurds or shives shaken out the hemp is "boiled off," as is done with silk or in wool-scouring, or as is done

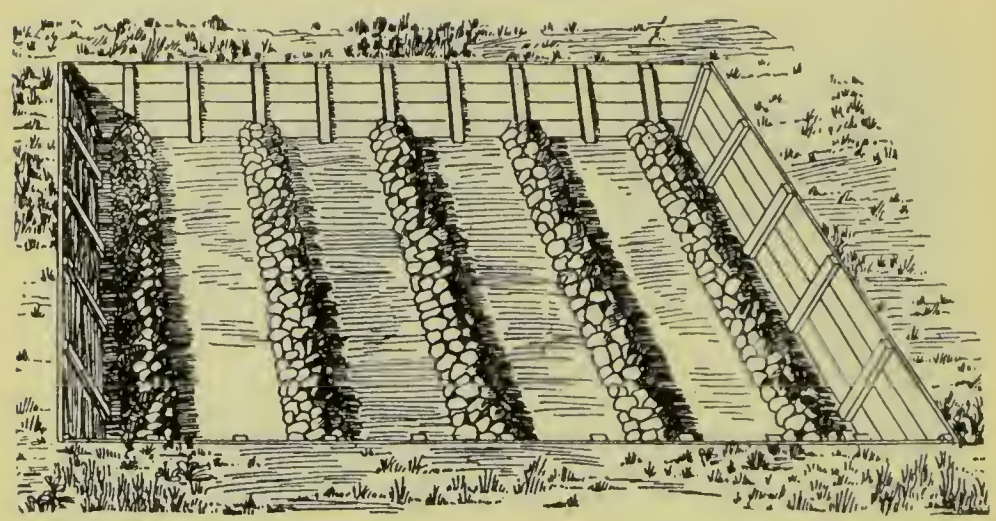

Fig. 5. Stone Retting Pit.

with yarns and fabrics after they are manufactured, to completely remove the hemp-gum and the other extraneous matters. Much of the preparation of hemp is now done by the manufacturer, and conducted by secret methods, not easy to learn. Another process of retting consists in placing the hemp in tanks of convenient size, holding five to ten tons of stalks, which are filled with water first impregnated with acid, and then emptied and refilled with water containing alkaline preparations, or *vice versa*. In some instances the hemp is first broken

or decorticated and the fibrous material only subjected to steeping. This requires much less space, and after steeping the fiber can be hung up to dry.

One method of "boiling off" the fiber before spinning consists in first passing the partly water-retted hemp through a softening machine consisting of sixteen sets of fluted rollers, set in a circular manner and made to move with a forward and back, or reciprocal motion. The fiber is then macerated in a nearly boiling solution of carbonate of soda and soap, then washed, first in cold water and then in water containing a small amount of muriatic acid, and again steeped in water containing soda without soap, to remove the acid; it is then placed in a solution of one part of acetic acid and one part of water and afterward in water alone, and dried and again softened. The process is too long, but is well rewarded in producing an exceedingly fine, soft, valuable fiber, highly adapted to the manufacture of fine linen, lawns and laces.

The finest Italian hemps are produced by those growing small plots upon soil very deeply tilled, often eighteen inches to two feet, and most extravagantly manured; the hemp being retted in artificial ponds, usually for five or six days, and then dried and again steeped.

It is not easy to reconcile much of the information given as to hemp culture and the preparation of the fiber in Europe with what has been found most practicable and advantageous in the cultivation in the United States,—especially that of the heavy seeding of one and a-half to two bushels per acre, where seven-eighths to a bushel properly sown

is found ample in the practice in America; but only an experience of years in the actual work of growing hemp can fully determine the correctness of the methods employed.

CHAPTER IV

EARLY CULTURE OF HEMP IN AMERICA

Hemp was one of the first plants under cultivation among the early colonists of America, and one of which most strennous efforts were made to extend the production. There is no record of the sources from whence the seed was obtained, and only surmises can be made as to varieties in cultivation by colonists from different parts of Europe, who settled at different points from New England to Georgia. It is quite likely that the varieties were nearly the same and of the common European character, growing quite irregularly four to seven feet in New England, and five to ten feet in Virginia and southward.

Hemp was cultivated in New England as early as 1629, while in 1662 Virginia awarded bounties for hemp-culture and manufacture, and imposed penalties upon those who did not produce it. Up to 1847–50 the clothing of every black woman in the South was made up of "one piece," fitting from the neck downward to the calf of the leg, with sleeves to the elbow, and held by a belt around the waist; while every black man's clothing was of two pieces, both made of a stout hempen cloth of light color, largely made upon the plantations, but more generally by the other colonists of the more northern states, Virginia, Maryland, Pennsylvania and

New Jersey. The establishment of a cotton mill at Augusta, Georgia, in 1848, commenced the weaving of cotton into "standard" sheeting and shirting to take the place of hemp and linen for garments and household uses. The "relics" of this industry for a long time held place in the garrets and lumber rooms of the palatial mansions, and are still occasionally met with in the mountain hamlets. In 1792, 3,000 bolts of light hemp canvas were made by one firm in Boston, worth $13 per bolt. In 1790, 2,729 families in Virginia produced 315,000 yards of hemp fabrics. The product of hemp and flax manufactures in the United States in 1810 was over 21,000,000 yards.

In 1765 Edmund Quincy, of Boston, prepared a work upon hemp-culture, which was published by order of the Massachusetts Assembly, for the purpose of impressing upon the minds of the colonial farmers the necessity for an extension of the hemp industry.*

In this work Mr. Quincy describes the male hemp as "lighter, smaller and more delicate, with fewer branches and a more hollow stem than the female," and states that the male comes to maturity some weeks before the female, yielding a much finer fiber, capable of being spun "into the finest threads most fit for linens of various sorts." Also, that among the Dutch, hemp has been used for the manufacture of canvas and sail cloth; in France "linens for sheeting and shirting of the very finest sorts" were made from it, and in Flanders the finest lawns, showing how important it was that

*Edmund Quincy was a brother of Josiah Quincy, grandfather of the president of Harvard. He died in 1785.

much care should be given to growing the hemp plant. The finest fabrics were made from the fiber of the male, or "fimble hemp."

The best soils for hemp culture, according to Mr. Quincy, are the "intervales," dark, loamy soils composed of sand and pure molds. In Pennsylvania the farmers have for many years raised hemp to advantage upon their well-drained lowlands. Hemp does much better in poor, warm land than upon a rich but cold soil. Experiments made by the settlers upon the bottom lands of the larger New England rivers showed that these "intervales" are equal to the Nile lands in Egypt, from which the cities of the Turkish empire and Italy receive a greater part of their fine hemp cloths.

Mr. Quincy's directions for the culture of hemp were to sow it as early as the land could be made ready, as "the earlier planted gave a heavier fiber coat, and to sow one and a-half to two and a-half bushels per acre, covering half an inch deep." From Mr. Quincy's directions it seems that the hemp was sown in rows two feet wide and two feet between, for convenience in getting to the male, which was pulled out after blossoming, and the female left to ripen its seed, as both seeds and fiber were saved. The yield was 700 to 1,000 pounds of fiber and ten to twelve bushels of seed per acre.

From this and other incidental remarks it appears that it was the early varieties of the common European hemp that was raised, as it grew four to seven feet tall and was very irregular in character. "If a tall-growing variety, and sown two and a-half bushels per acre upon rich ground, half the hemp would be smothered."

For retting, or "ratting," there is no mention of any other method than that of steeping or watering, and because steeping in the rivers killed the fish, artificial steep-pools were constructed. "After steeping for five or six days a bundle should be lifted out and rinsed to see if the leaves come off easily and the coat or bark readily opens and separates from the 'bunn' (boon)."

In breaking the hemp Mr. Quincy gives an illustration of a fixed, grooved base and a grooved head, to be raised by canes or a crank and let to fall upon the hemp. He also recommends the use of fluted rollers run by water power.

Several letters from hemp growers are published. Joseph Blaney and Samuel Barton, of Salem, January, 1765, state that they had planted ten acres the year previous, nine acres in rows and one sown broadcast, which grew four to seven feet. It was planted April 14 to May 26, one and a-half and two and a-half bushels of seed per acre, with a yield of 700 to 1,000 pounds of fiber per acre. They remark that when soil is well tilled hemp bears drouth better than Indian corn, and is not so likely to be killed by frost.

Mr. John Stevens* recommends sowing broadcast, and when pulling, to pull out paths two feet wide of both male and female, having as wide sections as can be reached into to pull out the male stalks first. He remarks that hemp is much injured by letting it stand out in the sun and dew.

At this time there was a British enactment in force, prohibiting the manufacture of hemp in the

*Mr. Stevens established the Stevens mills at Webster, Mass., the only mills in the United States now spinning and weaving linen.

FIG. 6. SPREADING HEMP ON THE GROUND IN KENTUCKY.

From Report No. 8, U. S. Dept. Agr., Fiber Investigation.

colonies, and Great Britian was offering a bounty of $40 per ton for raw hemp exported to England. A notice to this effect appears in the *South Carolina Gazette* of that date.

The coming of cotton lint, with its greater facility in spinning, turned the attention from hemp to the heavy standard cotton products, which served many purposes of coarse garments and household uses, while the appearance of jute, a cheaper and much more easily spun fiber, took the place of hemp for bagging and gunny sacks, crowding it still further, while the use of steam instead of sails lessened the demand for canvas, and lastly the substitution of steel wire ropes and those of sisal and manila in cordage generally, rendered the competition too severe; nor have the efforts to develop a better system of cleansing the hemp fiber of its resinous matter been as successful as the many other methods of substituting less costly and more easily manipulated materials.

Hemp was grown in New York state up to the last decade, while the industry still exists in the blue grass regions of Kentucky in all the pristine glory and primitive practices of its establishment a hundred years ago. The same antiquated methods of hand-sickles or scythes to harvest the hemp; spreading it upon the ground for the destructive action of the elements to ret it; and lastly, breaking it by hand, still prevail, as shown in Figs. 6 and 7.

From the eastern states the culture of hemp moved to the Mississippi valley, which at one time led in the production of a cheap, coarse fabric. In 1864 Missouri produced 28,000 tons. In 1892 the Empire Cordage Company, of Champaign, Ill., had

a hemp ranch of over 3,000 acres in cultivation, while several other ranches of 500 to 2,000 acres were in existence. Hemp was then grown upon the same land for thirty years in succession without fertilizers beyond the return of the foliage and the

Fig. 7. Slat Hand-Break in Operation.

ashes of the boon, or hurds, burned as fuel to run the machinery.

Here was the first successful application of harvesting machinery to cutting hemp, and of the use of the modern hemp-break for obtaining the fiber. The general changing of the climate to an irregularity in the rainfall, and the more rapid drying of the soil, compelled the search for more favorable

soil-conditions, a part of the hemp-growers going to the Platte river bottoms in Nebraska, a part to California, to use irrigation in the cultivation, and a part to Mississippi. During the past ten years hemp has been planted experimentally in all the states, in the southern especially. Wherever the conditions of fertility and moisture have been present, the result has been all that can be desired. A small plat planted at the Sugar Experiment Station, near New Orleans, in 1893, and each year since, has shown that a grand future awaits the hemp industry in the semi-tropical latitudes, provided an abundance of moisture can be regularly supplied. Of the result at New Orleans, Dr. W. H. Stubbs, Director of the station, says:

"This station has not systematically conducted any experiments agriculturally with fiber plants. In its anxiety to find a machine that will successfully decorticate ramie, we have planted the various kinds of fiber plants — ramie, two varieties of jute, American Sunn hemps, and several varieties of flax. No particular control has been exercised over these experiments other than to plant them and harvest them for use in the trial machines. In the use of American hemp, we had a varied experience; seed obtained from New York was old, and gave a poor yield and poor crop; seed obtained from some visitors, who witnessed some of our trials, was a great success, giving us large, strong, healthy plants, which were easily decorticated upon one or two of our ramie machines. * * * * There is no question in my mind about the practicability of growing hemp upon these soils when a machine is discovered which will handle it. My idea is to

clean the fiber on the mill machinery, so that there will be little left of gummy matter and other substances that cannot be easily removed in the laboratory. We have no trouble in removing the gums after we can obtain a machine that will successfully deliver the ribbons. However, we are not after a hemp machine; our object is to get a ramie machine, and hemp is tried only incidentally. We have tested upon ramie machines the fiber from hemp, jute, ramie, cotton, okra, etc., and we find that with a machine that will successfully give us ribbons, these ribbons can be successfully treated in the laboratory and be brought into excellent fiber."

There is no record or means of ascertaining the variety or varieties in cultivation by the early American inhabitants beyond surmise. The small importations of seed from China, India, Japan, and different parts of Europe, have been lost in the association and cultivation with the common American hemp plant. No systematical selection or preservation of any particular variety or strain has been attempted, nor effort to determine the effects of hybridizing or of climatic conditions. This interesting work remains for the botanist and chemist to elaborate and determine—a very important work, which is now in the hands of the special divisions of botany and chemistry of the United States Department of Agriculture, and from which full reports may be expected in due time.

CHAPTER V

WHY THE HEMP INDUSTRY LANGUISHED IN AMERICA

As household industries, hemp and flax were successfully grown, the fiber prepared and spun and woven in the United States up to 1825 to 1850; but from this time these industries languished and gave place to a cheaper, coarser but more readily manipulated product. The cotton-gin, and the greater facility and more ready adaptation of cotton to modern inventions, and improvements of spinning machinery left the older industry of hemp-growing and manufacture far behind in the race.

Cotton is an almost pure lint, requiring but little manipulation to prepare it for the spinner, while hemp is more obstinate, less flexible, and chemical processes and perfectly adapted mechanical appliances have been slow in coming to the spinners' assistance in taking the place of hand labor. Beyond this, the efforts to establish the manufacture of hemp and linen have been but a series of struggles against adverse circumstances from the very earliest times. No sooner had the American colonists made the effort toward the establishment of their home industries than the parent country placed her heavy foot upon their tender upspringing, and especially in hemp and flax was this opposition pronounced and continued with a deter-

mination which finally brought on the war of the American Revolution; but even after its successful termination, Great Britain continued to do by "diplomacy" and money in bounties and premiums what she could not do by force of arms and enactments, *i. e.*, control and destroy America's new industries.

Up to the beginning of the eighteenth century Great Britain had made no progress in the culture of hemp and flax, two plants very intimately connected in their manipulations, and of a nature so nearly alike as to be interchangeable in all branches of manufacture, and undistinguishable in product by the most experienced eye. But at the beginning of the century, after having by unfriendly enactments destroyed the Irish woolen industry, the British Parliament sought by bounties and premiums to establish the culture and manufacture of hemp and flax in Ireland.

In 1711 a "Board of Trustees of the Linen and Hempen Manufacturers of Ireland" was created by Parliament, and a system of bounties and premiums provided to strangle the industry in America and to increase the cultivation and manufacture in Ireland, and the export of the products of manufacture to America.

In 1710 Ireland produced but 1,668,574 yards of coarse linen cloth. In 1768 her product was 18,490,195 yards. In 1756 England made 26,000,000 yards, and Scotland about 12,000,000.*

Early in the eighteenth century England forbade the American colonists to manufacture hemp and

*No hemp or linen manufacture now exists in England or Scotland.

linen, and ordered that the raw material be sent to England. Great Britain also offered a bounty of $40 per ton for hemp fiber so exported. In 1728 Great Britain established a system of bounties to be paid for the export of hemp and flax manufactures to America, at the rate of one cent per yard for cloth worth less than ten cents a yard, two cents per yard for that worth ten to twelve cents, and three and a-half cents per yard upon all cloth worth over twelve cents per yard, which should be exported. These bounties were continued for over one hundred years, rendering the competition too great for any rapid progress of the hemp industry in America. In 1824 these bounties amounted to over $1,480,000, one-seventh of the value of the goods so exported.

Besides these export bounties, the premiums paid to the Irish hemp and linen industries were over $100,000 per year. The items for 1821 were:

To encourage the growth of hemp and flax	£9,250
To encourage the manufacture in the south of Ireland .	2,000
To be applied as the Board of Trustees deem best . .	10,350
Total	£21,600

or something over $105,000. At a meeting of the manufacturers in 1822 it was resolved "That it is the decided conviction of this meeting, founded upon long practical experience, that the bounty which has now for over seventy years been granted upon the exportation of British and Irish linens is of the most vital importance to the preservation of that branch of trade, and that without that bounty it would be quite impossible for the British and Irish hemp and flax manufacturers to compete in

foreign markets with the linen fabrics of the continent, where the price of the raw material, as well as of labor, is at all times extremely low."

At the dissolution of the "Board of Trustees of the Hempen and Linen Manufacturers," in 1828, and the refusal of the English Parliament to grant further premiums, the industry declined; and with the repeal of the bounty law in 1832, the industry found it impossible to continue in oldtime channels. The acreage in hemp and flax declined from over 182,000 acres in 1824 to less than 50,000 acres in 1848.

Up to the Revolution, the enactments against the manufacture in the American colonies had become more and more stringent, with the exercise of a system of espionage upon the part of British agents and spies and colonial governors, until it was a wonder that the colonists could possibly so far have established the industry as to have produced over 21,000,000 yards of hemp and flax manufactures in their households in 1810.

Nor was this unnatural competition the only difficulty with which hemp has had to contend. Cotton could be produced cheaper than linen, and the aim of most industries has not been to produce the finest and best, but something which could the most readily be sold at a profit. There has been no "fatherly" supervision of industrial affairs in America, as has always been the case by "patronage" or bounties upon the part of England and France; but in America industries have had to fight their battles single-handed and alone, and the history of each large industry of the country can today be traced by its milestone skeletons of disasters all along down the passing decades.

From the imperfect processes of cleansing and purifying the fibrous material in the bark or rind of the hemp plant from its gummy matter, hemp fiber is less tractable, more rebellious and difficult of manipulation to prepare it for the spinning frames, while more power and more labor are required in attendance. The inventive genius of the textile world is late in being directed to the necessities of this noble fiber. The industry still waits for the intelligent labor of the scientific agriculturist, the chemist, and the designer of textile appliances.

For instance, the cost of establishing a cotton mill, with all buildings and motive power, is about $10 per spindle, for wool $12, and for hemp $30. While the horse-power required for spinning a given weight of raw material will move 120 cotton spindles, or 140 woolen spindles, it will move but 50 hemp spindles, while the proportion of labor required is in cotton five persons per 1,000 spindles and in hemp 25 persons per 1,000 spindles. The cost of the raw material does not greatly differ, but the cost of spinning was much greater, while those growing hemp upon a small scale were not able to enter upon the expensive experiments and investigations necessary for the desired improvements.

Worked by hand, hemp furnishes a thread of extreme fineness almost equaling silk, much finer than cotton, and much finer than can be produced by the present imperfect mechanical methods, excepting as manipulated upon "spun-silk," or on mohair machinery. Lace threads are spun from hemp by hand to the fineness of 600 miles for each

two and one-half pounds of hemp fiber, while the present hemp machinery cannot spin beyond one-half of that. Cotton and wool machinery nearly equal handwork, but do not exceed 350 miles to each two and one-half pounds of material.

The solution of the problem of a perfect production and preparation of the fiber and of the adaptation of processes and mechanical appliances to its rapid and economical manipulation, is one of the most important questions, as it is one of the most promising of an ample reward, at the present time. The question has been time after time urged by manufacturers and others interested for the last half century, but still awaits a perfect solution. The jury of the International Exhibition at London in 1862 most earnestly called attention to the necessities for an earnest effort to overcome the difficulty. They say:

"We notice, in the first place, that though flax is a material most easily adapted for spinning yarns, being produced by hand labor quite equal to silk in fineness, and though the raw material of flax in the state of fiber is about the same price as the better kinds of cotton, the yarns produced from flax by machinery, taken in equal length for the same weight of fiber, appear to cost the most of all. We must also acknowledge that it is with the greatest difficulty that flax-spinners have been able to produce by machinery yarns of an extreme fineness, though still inferior in this respect to the fineness of the cotton yarns. As a principle, the fundamental operations for the spinning, except perhaps the preparation of the raw material, are the same for all fibrous substances. The combing or carding,

the drawing and spinning, constitute, without any important distinctions, these various operations; still such will cost much more for some one of these materials than for others, even though this material may not possess a nature deficient in spinning qualities.

"The cause of this difference is that the more costly fabric is produced from material which is worked with greater practical difficulty, and requires more effort to complete; this is especially the case with the flax, the machinery for which must be decidedly stronger than that used for cotton, and the whole flax-spinning system must also have much more steam power applied, in consequence of the flax fiber not being sufficiently purified and freed from all heterogeneous substances, which, of course, present an obstacle to the sliding or drawing, the base of all spinning operations. On the present occasion we shall endeavor to give some explanation on the subject of steeping flax, this being the principal process by which more or less softness or purification of the fiber may be obtained.

"The great fault of the flax fiber is the excessive quantity of gum, which is not extracted by the present steeping [water retting] process; when a new process shall have been discovered to remove completely this objection, there is no reason why flax fiber should not be spun as easily and as fine as cotton. It is to be hoped, also, that by such improvement we may eventually obtain a class of yarns more elastic, and that the cloth made from them may weave more readily, and in the end give greater satisfaction and durability. If we pass from the flax fiber to that of hemp and other similar

substances, we find the hemp inferior to flax in softness and minuteness of subdivision, making it more difficult to spin; we find also that China-grass has the same defect in a much higher degree, while it is also much more costly. If jute manufactures have made such rapid progress it can be easily accounted for by the low cost of material, combined with a considerable amount of spinning quality.

"We may remark, before concluding these reflections, that great attention is now being given to the flax-steeping process, and in consequence the real cause of the difficulty of the fiber for spinning, as explained above, has thus become every day more generally known. We may hope, therefore, that at no late date the process of steeping will be improved to an extent equal to the great progress which the other manufactures, dependent on the aid of chemistry, have lately made."

Since the more complete development of the German textile industries, later in their establishment, and based upon older methods, but with very much of improvement, the spinning of hemp and flax has made rapid strides, and the demands for hemp of a character to take the place of flax, because a fine hemp fiber can be more cheaply and economically prepared than flax, is rapidly increasing. At no time has it been forgotten that the linen fabrics of hemp and flax are the more desirable, and the public mind is becoming more and more awakened to the necessities of some determined efforts to develop this new industry — new, especially, to the American people.

The nature of the fibrous material of the hemp plant is such that a coöperation of the chemist, the

farmer and the textile manufacturer, or the inventor of improved textile appliances and methods, is necessary for the quickest results. It is found to be practicable to spin hemp upon "spun-silk" or mohair machinery by the combing process, when once the hemp-gum or resin is completely removed.

The products from the hemp plant are the most desirable for all purposes of garments and household use, and if its manufacture can be brought to the necessary point of economy, the hemp industry will lead in the world's textile affairs. We have seen that hemp is the most widely diversified and most important plant in cultivation in the Old World; while sufficient experience has been had with the plant in America to show that the character of the fiber is such as to warrant a systematic effort to establish its cultivation and to build up another grand industry for the American people.

No plant is more simple of cultivation and manipulation, none more susceptible to the care of the husbandman, none more capable of a widely diversified product, and none is more universally adapted to American soils and climatic conditions, or to supplying raw material of the nature and character required by manufacturers of cordage and fine linen fabrics.

The hemp industry is the last of the great sources of the employment of capital and labor to feel the revivifying influences of more modern inventions; but the writer is confident in the belief that the same labor which has been given to other agricultural products and textile manufactures will place hemp at the head.

CHAPTER VI

HEMP VERSUS FLAX

Why hemp? Why not flax? Why not ramie or China-grass? Why not sisal, or Manila, or jute? With the exception of hemp and flax, in the fibers of which there is no essential difference in character and none in the machinery of manufacture or in the products, when systematically conducted, the spheres of the other plants are entirely different. Ramie or China-grass can be made to produce an exceedingly fine fiber, when its nature is perfectly understood, and the right variety, adapted to chemical and mechanical processes, is discovered; but its culture is confined to tropical or semi-tropical climates, while its yield is not more than one-fourth as much per acre as that of hemp. As yet no one has made such an exact study of the plant and its fiber, its adaptability to mechanical manipulation and to the production of desirable fabrics, as to be able to furnish definite directions for its culture and manipulation, and until such time as this is done the attention of the agriculturist were better not especially directed to it. Sisal hemp and Manila hemp are not true spinning fibers, and are not susceptible of a fine subdivision, nor can they be spun in fine numbers for the manufacture of fine fabrics. In the sphere of their uses as cordage they are valuable, and a great acquisition to the cordage industry. Attempts to grow sisal

hemp in Florida have not been perfectly successful, nor have attempts to grow Manila hemp outside the Philippines.

For various reasons flax is less adapted to cultivation in the United States than hemp. Flax only succeeds in a rather low mean temperature and upon a rather cold soil, with a very regular moisture supply. These conditions are not generally assured in the United States. Flax requires special fertilization and a rotation of crops which shall leave the soil specially conditioned, while it can be grown but once in six to eight years upon the same field. For hemp the ordinary coarse farm manures are all that is necessary, and it may be grown each year in succession for half a century upon the same land.

While hemp does best in a warm, moist soil, it is so hardy that it may be sown early, and as it soon shades the ground, it does not suffer from the short drouthy spells as does flax. Flax requires two and a-half bushels of seed per acre, hemp but one bushel. Hemp grows rapidly and matures for fiber in eighty to ninety days, while flax is tender, must be sown later, and grows slowly, requiring the whole season to mature. Hemp never suffers from weeds,—in fact, is a weed-destroyer,—while in the general condition of American soils, flax is smothered by the more rapidly-growing weeds, notwithstanding considerable labor expended in weeding. Hemp is never blown down, while flax very often is; hemp costs but twenty-five to fifty cents per acre to harvest, flax costs five dollars per acre. Because of its greater length, it is as easy to handle three to five pounds of hemp as one pound

of flax, and it costs only about one-half as much to break and clean the fiber. Flax yields but 300 to 400 pounds of fiber per acre, while hemp gives 1,500 to 2,000 pounds.

There is no essential difference in the two fibers when prepared for spinning; both are equally well adapted to the production of the finest threads, linens, lawns and tissues. The report of Dr. W. R. McNab, Professor of Botany in the Royal Agricultural College, states in a description of flax that "fibers appear as a greatly elongated cylinder, with a cavity sometimes well marked, sometimes scarcely visible, at other times wanting. Adhering to the fibers, and often more or less discoloring them, were fragments of tissue, sometimes the epidermis with stomata, from the stem; at other times the cells of the soft bass- or wood-cells from the central portion of the stem. The diameter of the fiber varies from about .0004 to .0006." In describing hemp, he says: "The fibers are more or less separate, some entirely free, others in small bundles. The fibers vary very much in diameter, some being very broad, others narrow, and they appear like longitudinally-striated cylinders. Sometimes a cavity exists, at other times none can be traced. The fibers are, on an average, from .0005 to .0007 in diameter, and in one fiber in which the diameter was .0007 the diameter of the cavity was .0001. Some cellular tissue was observed adhering to the fibers, but they were cleaner than the fibers of Irish flax. Like Irish flax, the hemp consists of bast-fibers, and is, anatomically and physiologically, as well as chemically, different from the fibers both of Manila hemp and *Phormium*" (New Zealand flax).

While hemp and flax are mixed in spinning, or one is substituted for the other, it is the chemical preparation of the fiber which determines its fineness. The cost of the culture of an acre of flax is greater than that of an acre of hemp. While the value of the product of an acre of flax is $40 to $50, that of hemp is $75 to $125, from its greater yield under similar conditions; while south of a latitude of 40°, in a mean temperature of 50°, two crops of hemp may be grown each season, or a crop of hemp and a crop of peas, to keep up the fertility of the soil. The hemp-hurds furnish all the fuel required to make steam to run the machinery employed, while from the long tap-root of hemp it is less exhausting to the soil, and if the refuse is returned, the expense of manures will be very much less in proportion.

Neither crop can be advantageously grown for both seed and fiber, although in the above comparison we have given flax the benefit of both seed and fiber, and only fiber for the hemp. The product, when grown for seed, is about the same with both; but for seed alone flax is much more easily handled, as it is sown at the rate of one to two pecks of seed per acre broadcast, harvested by a reaping machine or "header," and threshed by an ordinary thresher. Hemp will grow fifteen feet upon good soil, and six feet upon the dry uplands, as surely as flax will two to three feet, and yield three times the profit in fiber.

The methods of handling the hemp and flax straw to obtain the fiber do not essentially differ in the retting and breaking, while the expense of handling the flax after breaking is much the

greater. Hemp is much better adapted to the employment of labor-saving appliances than flax, as its length enables the handling of three or four pounds as readily as one pound of flax, and there is less liability to "tossing" or tangling.

For these and many lesser reasons, after twenty-five years of close, careful study and practical experience in the cultivation and manipulation of both plants from the field to the loom, the writer believes hemp to be the coming fiber-bearing plant of the world, and that it is destined at an early day to make its way to the head in importance commercially and industrially, as well as upon the farm.

CHAPTER VII

SOIL AND CLIMATE ADAPTED TO THE CULTURE OF HEMP

THERE is no fact in agriculture more conclusively established than that with a deep, mellow soil and an abundance of the special plant-food required therein, an abundance of moisture regularly supplied, and a high mean temperature, plants will grow to perfection Hemp is no exception. These favorable conditions are more readily realized in some sections, some localities and in some climates, than in others. A farmer possessing land, and desiring to successfully grow hemp, or any other special crop, will select the soil, lay of the land and conditions best adapted to it, and apportion his land to the crops to whose peculiarities of growth it is best suited.

Flat lands, or bottoms, or alluvial, adapted to hold moisture, but which may be readily drained, are best for hemp, especially when lying along streams, and not much elevated above the surface of the water. A regular supply of moisture, too much rather than too little, and a soil well filled with the humus of decaying animal and vegetable matters, are most favorable. But all soils can be made suitable for hemp, provided expense is not considered. If uplands are used, the plowing should be very deep, the earth made mellow and friable,

and an abundance of humus incorporated to hold moisture in case of periods of drouth where irrigation cannot be provided. Irrigated plateau lands, containing proper proportions of sand, mold and humus are good. In fact, bottom-lands are better adapted to hemp than to most other crops, because hemp requires a larger amount of moisture, and in case of periods of drouth, it can then send its long and strong tap-root far down for it. With the addition of an abundance of moisture, any soil well adapted to a perfect growth of any crop can be made serviceable for hemp. With an abundance of moisture and special plant-food, hemp grows much more rapidly in climates of a high mean temperature. A crop of hemp planted in Mississippi, April 18, 1894, grew fifteen feet, and was ready to harvest for fiber in eighty days. Another crop planted upon the Sacramento river bottoms in California, upon similar and nearly equally favorable soils, was fourteen and a-half feet high and ready to harvest for fiber in 115 days, the only apparent difference in conditions being the mean temperature of May, June and July, which was nearly ten degrees higher in Mississippi than in California.

Contrary to cotton and corn, hemp is sown broadcast, and no cultivation can be given the crop after it is planted. Again, in the culture of cotton, which is a short plant with much fruit, shallow plowing is best, so that its tap-root may early strike hardpan and the plant be forced to fruiting. The effect of nitrogenous manures and soils rich in humus is to force the plants to a tall growth, hence the special fertilizers for cotton should have proportionately less nitrogen. With hemp, however, the

object is to produce the tallest plant possible, hence the soil should be deep and the special manures used should contain a large amount of nitrogen, and the soil an abundance of humus to hold and supply the plants with soluble plant-foods and a regular supply of moisture.

Few plants grow so rapidly as hemp, or take up so much moisture for their best development. Hemp has often been observed to grow from five to six inches per day, and if the hemp plant is 90 per cent moisture, and the crop upon an acre weighs 6 tons (while that of a crop of barley weighs but 1 ton), it can be readily seen that an acre of hemp would require six times as much water. It is estimated that an acre of barley requires or takes up and evaporates 1,000,000 pounds of water, or 150,000 gallons, during its growth. Hemp should take up at least three times as much, or 450,000 gallons, which represents a rainfall of twenty to twenty-five inches during the three months of its growth, while it is rare that one-half this amount is made available through rainfall. An irrigation of one inch of water per week in addition to the rain which fell during the season of 1899 gave a growth of hemp of seventeen feet in one hundred days in latitude 40°, while the ordinary hight without irrigation was eight to nine feet.

A hemp crop is less exacting upon whatever soil it is grown upon, from its long tap-roots, but it, will be of much less hight, and as the yield of fiber is 150 pounds per acre for each one foot of growth, excluding about one foot of tops, it follows that the planter will be amply rewarded for his labor in securing a tall-growing crop. In proportion to

depth of cultivation and fertility of the soil, and the warmth and moisture, will be the yield.

Upon dry soils it is better to plant crops which can be often cultivated to conserve the natural supply of moisture and give free access to atmospheric influences. It is not enough, however, to dam up a supply of water; the moisture must be in circulation, and not so great as to exclude the air, nor must the soil be sour, nor the water allowed to stand for any length of time; although a rainfall of six inches in twenty-four hours upon a crop in Mississippi in 1895 had no ill effects, although the surface of the field was uneven and the water remained in places for four or five days.

Thanks to the fact that hemp requires but a short season to mature, a crop of cow-peas may precede or follow a crop of hemp, and thus keep the soil in fertile condition. A crop of peas followed by rye or vetch, to be turned under in March, will keep a soil in good condition for hemp, after the ground is once properly prepared, especially if the refuse of the hemp is returned to it. No crop better rewards the outlay to obtain a tall growth than hemp. Upon an old cotton field of twenty-five acres, in which the cotton rows ran from one side to the other, experiments made in 1895 by skipping twelve rows and then applying 1,000 pounds of cotton seed upon the next twelve, then skipping twelve rows and applying ten loads of manure from a mule shed, and then skipping and applying 500 pounds of cotton seed and five loads of manure, and following the field across the rows with a four mule plow nine inches deep and sowing the hemp in March, gave seventeen to nineteen feet

of hemp where fertilized, the lowest part of the field giving the tallest hemp, while where no manure was applied the growth was but five to seven feet. Upon similar soil adjoining, upon which there has been cow-peas broadcast and pulled off the year before, the hemp was eleven to twelve feet, while upon a field in corn the year before, with cow-peas in the rows between the corn, the hemp was seven to ten feet, the ten feet in rows, as the cow-peas had been.

At Augusta, Georgia, in 1898, hemp grew fifteen feet in ninety days with an unusually dry season and no fertilizers. The land was old Savannah river bottom. Upon good uplands, not fertilized, hemp was seven to nine feet.

With perfect preparation of the level uplands in South Carolina, and without irrigation, several plots of hemp grew twelve to thirteen feet in ninety days, yielding at the rate of 1,500 pounds of fiber per acre, worth six and one-half to eight cents per pound. With an abundance of moisture the growth was sixteen to eighteen feet and the yield at the rate of 2,000 pounds per acre—a difference of $35 to $40 per acre.

Good crops of hemp are now grown upon the bottom lands of the Platte river, in Nebraska, although the rainfall is light and irregular. Better crops are grown upon the bottom lands of the Sacramento river, in California, with little or no rainfall, but the mean temperature is more favorable. Better crops still are grown in the valley of the Kern river, southern California, by irrigation, but upon less fertile soil, the moisture and higher mean temperature causing the difference. Hemp sown in

the warmer months grows proportionately more rapidly. The rainfall upon the Atlantic coast is more regularly and more evenly distributed; the mean temperature is higher, and natural conditions the most favorable of any section of the country. A perfect condition can be made by supplementing the rainfall by diverting water from the many streams, or by artesian wells and windmills.

The bottom lands along the many considerable streams upon the east coast offer especially favorable conditions for growing hemp. These lands are deep, and consist of deposits of vegetable matter washed down and composted in the soil, and are exceedingly fertile and well adapted to the growth of a plant with a long tap-root, like hemp. These soils have a tendency to supply moisture to plants by sub-irrigation, which brings a continuous supply to the surface. Upon lands so low as likely to be overflowed, dykes or low levees might be necessary, with openings, to be closed until danger of an overflow is passed, and then opened for drainage in case of heavy rainfall. Clay soils, or those likely to "pack" or "run together" after heavy rains, are objectionable. Hemp planted upon "buckshot" (clay) lands in Mississippi grew a foot high, and stood still for a period of forty days of dry weather, and grew to ten feet high after the rainy season opened. Five hundred acres of hemp planted upon clay soil in Mississippi in 1896 came up finely, but was met by a drouth when three feet high on the first of May, which continued until September, when the ground baked like adobe brick, and the hemp burned up, while a few acres upon the alluvial banks of a bayou grew to fourteen feet in hight.

Hemp planted upon Staten Island, New York, March 24, 1899, was cut for fiber June 24, eleven feet tall; the same ground was replanted July 1 and cut for fiber October 4, eight to nine feet tall. The soil was a warm, sandy loam, and irrigated by applying an inch of water once a week. The rainfall was very light. Hemp planted August 1 grew to a hight of seven feet by November 1, and a part planted September 1 was three feet tall and in blossom upon the 10th of December, and killed by 20° of temperature. China hemp, grown for fiber on Staten Island, New York, is seen in Fig. 8.

Many years of practical experience with fertilizers shows that with the exception of acid phosphate and sulphate of ammonia, to be composted with cotton seed and farm refuse, and manures, the commercial fertilizers are not economical for growing hemp for fiber. Hemp is a plant requiring a large amount of humus, supplied by coarse animal and vegetable matters held in the soil in decay, to furnish the soluble nitrogen and moisture. Nor is cotton-seed meal of benefit in proportion to its additional cost. As a plant food and as a holder of moisture, and a mechanical preparer of soil, cotton seed is of itself a perfect fertilizer. Applied when plowing in autumn, at the rate of 500 to 1,000 pounds per acre, according to condition of the soil, nothing else is required. If there has been a crop of cow-peas or soy beans, 500 pounds is sufficient. The rotation kept up by rye or vetch, hemp, peas, and again rye, gives as perfect a condition of soil as can be desired. The roots of the hemp decay early, the peas penetrate deeply and leave the soil porous and supplied with nitrogen and

Fig. 8. Section of a China Hemp Plot Grown for Fiber.

humus; while rye and vetch keep the soil employed, and the three furnish feeding material more than paying their cost, while the rotation prevents any cloying of the soil appetite. An application of 200 pounds of bone-meal in November has the effect to warm the soil and hasten germination where hemp is sown early, and to stimulate the hemp to a quick, early growth, before it comes to assimilate the coarser foods, and to give an increase of a foot to a foot and a-half in the growth.

The hemp plant produces four to six tons of dry matter per acre, of which three to five tons is refuse, and if the machinery is run by water-power all of this refuse may be returned to the soil. If so done, it is spread as evenly as possible by a manure spreader, some two inches deep, before plowing. The result is to add to the humus in the soil, to improve its mechanical condition, and to hold moisture. Of itself this refuse, largely of woody matter, does not contain the fertilizing elements of the fibrous material in the bark; these come out in the steeping, and should be run upon the land. If steam is used to run the machinery, then this four to five tons of hemp shives or hurds is the cheapest fuel, and will be more than enough to run the machinery

CHAPTER VIII

GROWING HEMP FOR SEED

The only assurance that the proper, perfect seed will be at hand for seeding for fiber is to select the strain desired, and to raise it. At present the hemp industry in all its branches presents a fine opportunity for a careful study of all its requirements, not only upon the part of the farmer but that of the botanist, chemist, and inventor of improved appliances as well. There are hemp ranches in various parts of the United States, and many of these are of an extent to warrant the expense of an exact investigation of all particulars of seed, of varieties desirable, and of improved methods of preparing the fiber, as well as of spinning it; but every one of these particulars now awaits the authoritative determination of science and exact practice.

As there is no careful selection and propagation of seed today, there is no means at present of determining the advantages of different varieties in cultivation. The seed found in market may have been imported from Bombay, or from Italy, or from London, or it may have come from Arkansas, or Missouri, or Kentucky. The result will be an uncertainty. Seed loses its germinating power in two to three years, from the drying up, souring or fermenting of its high, oily nature, and becomes

rancid and dead. As at present obtained, the seed largely comes from allowing the hemp grown for fiber to stand until the seed begins to ripen. It is then saved, although the fiber is coarse and hard, and is called "lint seed," or "linseed." Added to this, there are numbers of "volunteer" plants scattered about the highways and byways of the localities where hemp is grown, springing up from seed scattered in autumn in fence-corners and upon the edges of fields, and often places in hemp fields where seed failed to germinate well and the stalks grow too large for use as fiber, being left to stand for their seed to ripen. Small amounts of Indo-China seed have been imported at times, but grown near to the European varieties, which are earlier and more prolific of seed, the new importations are either crowded out or the plants cross with the other varieties. Many hemp growers claim that in this manner hemp degenerates to a less valuable plant. If so, the more care must be exercised to preserve the strain found most desirable.

Three varieties are at present found in the hemp fields of the United States, mostly mixed and presenting the same characteristics of growth — tall and graceful, or short and "scrubby," and their intermediates. The same field may present a growth of from seven to nine feet in hight, or four to six feet, although the general character of the growth is of a hight some two to three feet taller than the various European hemps.

Selecting the shorter stalks and propagating by continued selection, the apparently perfect Smyrna variety is obtained. This is an early, rather short-growing variety, inclined to branch, to flower early,

and to produce a large amount of seed. If the quantity of seed is the object, this is the variety to be cultivated; but its fiber product is coarser, less in amount, and harder to manipulate. Two crops of this variety may be grown for fiber each season in the latitude of 40°.

Another variety, supposed to have originated in the East Indies—a tall, slender, gracefully growing plant, later in maturing—is also obtained by careful selection. It is equally hardy, but bears less seed, and is crowded out by the earlier, more prolific varieties, unless great care is given to selection and preservation of the strain.

Still another sort, of sufficiently distinct characteristics to be called a variety, is supposed to be a cross between the other varieties. It presents many features common to the slender, graceful stalk of the China, but is earlier, bears more seed, and is inclined to a stouter, less graceful habit, with more tendency to branching. This is the variety in general cultivation where any attempt at selection is made; and when grown for fiber is sufficiently early to allow of being followed by a crop of peas to advantage, while in the latitude of 35° two crops a season may be grown. When selected for propagation for a pure strain, it develops occasional plants of both the other varieties which shows the importance of care in selection.

With the Smyrna variety no care is needed to preserve the purity of the strain. It is the lowest in the scale, and ripening earlier, and bearing more seed, it crowds out the other varieties. The only care to be taken is to see that all seed is better, and the plants from it are more vigorous and robust;

that they have ample room to branch, and that the male stalk is near by. The seed should also be allowed to ripen, or very nearly so, before it is harvested, and given ample time to dry and ripen before it is beaten out. Nor should the piles of seed and chaff be so deep as to heat or excite fermentation, and all unripe or light-weight seeds should be blown off in the cleaning.

In the American variety the tendency will be to a crowding out by the Smyrna influence, and a degeneration result, unless great care is given to a weeding out of the earlier male and shorter and less vigorous female plants. The plants of the distinctive American variety will grow the most vigorously and tallest. The Indo-China variety must be carefully guarded to preserve its purity, and in that grown for seed a careful selection must continually be exercised; the tallest, most graceful stalks steadily chosen from which to sow the seed for future seed-growing.

In cultivating hemp for seed the conditions are the reverse of those for cultivating hemp for fiber. For fiber the object is a tall, rapidly-growing stalk, without branches and with little or no seed, while the stalks are grown slender and so shaded as to give a fine character to the bark in which the fiber is contained. In growing for seed it is a short, stout, slow-growing, coarse, branching stalk, with every part exposed to the full influences and effects of the sunshine and the wind, the heat and cold of atmospheric changes. The ground is less deeply tilled, as with cotton, less fertilized, withholding nitrogenous manures entirely, as an early, abundant fruiting is the purpose.

The system of cultivation as practiced for cotton or corn is best suited for seed hemp. The ground may be bedded up, or planted level, or in furrows, if there is great liability to drouth. Not so much moisture is required, although the cultivation keeps the roots mulched.

The seed is sown two quarts to the acre, in rows or drills, or planted in hills, as is done with cotton and corn, and cultivated in the same manner. No thinning out is done until the male stalks begin to show a tendency to blossom, when all male stalks, but one robust one to each three or four feet of row, are cut out with a reap-hook, and also the less vigorous female stalks, so as to give abundant room to the remaining ones to branch. The hemp thus removed is dried and put under cover for fiber. Should the wild morning-glory or tie-vine make its appearance, it must be removed by hand. When the male has shed its pollen and begins to turn yellow, it should all be cut out, and that without branches be saved for fiber. The branching stalks are thrown into the compost heap.

With the Smyrna variety, planted upon rather dry and not very fertile soil, the seed will begin to ripen in 100 to 110 days from the time of sowing, and when the first seeds begin to scatter out, the stalks are cut by hand with a reap-hook or scythe, and carefully stood up together to become partly dried, and then put under cover. In housing the stalks, they should be placed in a barn with a tight floor, or under a shed where the earth is hard and has been carefully swept.

The American variety is ten to twenty days later in maturing, grows taller and with a more

vigorous, more branching stalk. On Staten Island, in 1899, a stalk of this variety standing alone grew fourteen feet tall and six inches in diameter at the ground, and gave two quarts of seed.

The Indo-China variety will not always fully ripen its seed north of latitude 40°, unless planted upon a rather dry, infertile soil, and as early as the first of April. This variety bears much less seed than the other varieties, hence the danger of its being crowded out.

Some judgment must be used as to the time of harvesting the hemp grown for seed. At times pigeons, blackbirds and sparrows are numerous, and feed upon the ripening seed. At times the season may be very dry, and the seed will begin to shell out and fall, when it is well to cut early. With an abundance of moisture the seed will not be as likely to shell out.

For seed the hemp is cut by hand with a reap-hook or scythe, as seen in Fig. 9. The stalks are then stood up to dry. When dry they are threshed upon a hard, dry place on the ground, or upon the barn floor, by hand with flails, or the seed is beaten out with a cudgel an inch in diameter and four or five feet long, while the hemp stalks are held across a beam or log; or the hemp stalks may be run through the hemp-breaking machine and the seed winnowed in a fanning mill. Care must be taken that the seed does not heat or ferment, and that it be thoroughly dried before sacking. It is not desirable to place it in bins for storage, on account of its tendency to ferment and grow rancid. When sacked it should be in two-bushel bags (88 pounds), and piled two sacks near together and then two

across them, in the manner cord-wood is piled to dry, carefully secured from vermin and dampness. The product per acre varies from twenty to thirty bushels for the Smyrna, to fifteen or twenty bushels for the China variety, depending somewhat upon soil and cultivation.

Hemp seed is valuable as bird- and poultry-food, to make oil for paints, and for soap-making,

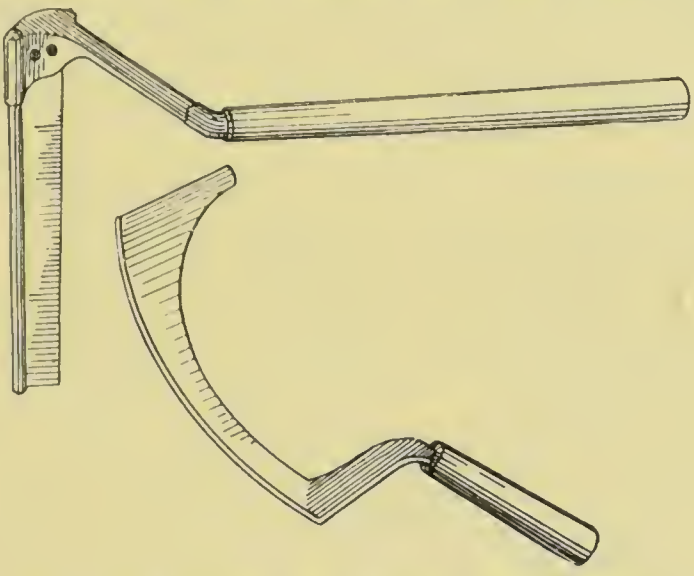

Fig. 9. Reap-Hooks for Cutting Hemp by Hand.

seed cake being valuable for feeding to stock and as a fertilizer. Ground and mixed with other feed in small proportion it is fed to animals, although an authoritative determination of its value and effect is wanting There is no better fertilizing element, bnt the seed must be sealded or heated by composting or crnshed, before applying it to the land. The priee of prime seed varies from $1 to $4, according to the ability of dealers to "corner" the market.

CHAPTER IX

THE CULTIVATION OF HEMP FOR FIBER

THERE is no more interesting task than that of carefully preparing a piece of land by deep tillage and the application of manures in a manner to produce a tall, perfectly growing fiber-bearing plant, like hemp, perfectly adapted to the production of a fine, soft, silky fiber, and possessing high spinning qualities adapted to the manufacture of fine fabrics. There is a charm in seeing a plant respond to intelligent preparation of the soil in the steady growth and development of a character exactly corresponding to what modern agricultural science has shown to be practicable. In the growth of no plant is theory more surely borne out by practical results than with hemp. A long, careful study of the nature of the plant has shown that its character and growth may be as absolutely controlled and directed as the breeding and development of a fine animal, or any vegetable or fruit. The products of the soil are what you make them, and none is more susceptible of the shaping of agricultural fine-art methods than hemp. According to exact methods and care in cultivation, the fiber of the hemp plant is made to become of the fine nature and high spinning qualities rendering it of great value. Nor is it the variety of hemp alone which insures its high character, but the high cultivation,

the application of manures of a character to develop a tall, slender and rapidly-growing plant, and a thick seeding, which insures an even growth and a perfect shading of the soil and the stalks of the hemp, and protects them from the injurious effects of sharp changes in temperature, and, above all, the periods of drouth, in which the plant is deprived of a proper supply of moisture, and the growth and exact plant-formation checked and interrupted for such periods as cause it to take on a different character of fiber and growth for self-preservation.

No plant will more completely adapt itself to soil and climatic conditions, producing therefrom as high a character of growth as possible; and none will more exactly respond to high cultivation, or be more susceptible or sensitive to its conditions and surroundings. Irregularities in character of soil, the depth and manner of plowing and pulverizing it, and the amount and composition of manures all produce their effects upon the character of the hemp plant, as does an even or uneven, thick or thin seeding, and an irregular or a deep or shallow covering. Exact attention to all of these is necessary for the most perfect result, but none are more important than the provision of a deep, mellow soil with all abundance of humus and moisture-holding manures, high in nitrogen, to insure a quick germination and a rapid growth.

This fact is very plainly illustrated in all animal and vegetable life, where cold, poorly fed and upon innutritious foods, such animal or plant exhibits a weak, scrubby, half-starved appearance, while the irregularities of care and condition give large and

small, and coarse and fine products, as generally found among plants in a wild state. Such plants are poorly adapted to the production of fine fruit, fine seed, or fine fibers, while years of careful culture and breeding are required to bring wild plants or wild animals up to the most perfect nature.

Upon whatever soil the hemp is to be grown, a much taller, finer plant, much better adapted to the production of a fine fiber, and yielding a much larger product, will result from the following conditions:

1. A deep, thorough stirring and pulverizing of the soil. With the long tap-root of the hemp plant, this thorough tilling is of itself a large increase of the plant-food supply, and secures the plant against drouth by enabling it to obtain moisture from below, and also puts the soil in condition to take and hold a much larger amount of moisture from whatever rain falls, and in condition to be taken up by the plant as required. All foods of animals and plants are more readily assimilated when furnished in soluble form, which is not possible without the presence of moisture.

2. The application of a sufficient supply of coarse animal and vegetable matters, to give a light mechanical condition to the soil, and to assist in holding moisture as well as to add to the humus, nitrogen and available plant-foods if the conditions are favorable. Nitrogen is the most important element in the production of a tall, rapid growth of hemp, while it is a tall, rapid growth of plant which is desirable for fiber, rather than a good yield of seed. Hemp yields 150 pounds of fiber per acre for each foot in hight, hence the

advantage of the tall plant. Grown rapidly, the fiber is softer, finer and of a more silky nature, and of a much higher spinning quality. Perfect productions of high character are what pay the best in agriculture. The world is full of "cheap and nasty" goods of very little value, and affording no profit to the producers. A crop of peas before or after a crop of hemp, and in preparation for the next crop, is highly desirable, because of furnishing the coarse plant-food to the soil in decay, and mechanically deeply preparing it, and because cowpeas give to the soil food and put it in condition for hemp. The best manure is cotton seed, put into the ground in autumn, at the rate of 1,000 pounds per acre. The next is a compost of cotton seed and farm manures of equal proportions, with an addition of 10 per cent of acid phosphate, applied according to the condition of the soil. The only other addition to the compost of 1,000 pounds cotton seed, 1,000 pounds barn manure and 200 pounds of acid phosphate, would be 250 pounds of sulphate of ammonia. The cost of this compost would be $5 for cotton seed, $6.50 for sulphate of ammonia and $2.50 for acid phosphate, a total of $14, or $7 per acre. This would only be required upon old, exhausted cotton lands, while this amount would be sufficient for four or five acres, according to fertility, and for ten acres, provided a crop of cowpeas broadcast had preceded. Cotton seed and barn manures have always given the best results. Mineral or commercial fertilizers are not generally desirable for the proper growth of hemp for fiber. An application of bone meal in the autumn, that it have time to become soluble, is a valuable stimu-

lant to the early germination of the plant, while the rootlets are small and tender, and a prime introduction to the coarser manures.

3. The character of the seed, and an even distribution, and even covering, and of a proper amount per acre. One bushel of clean, bright, plump,, glossy seed one year old, per acre, is best, while if two years old, or uncertain in character, it should be tested before sowing. A certain number of seeds should be placed between two moist woolen cloths in a vessel to keep them wet, and placed in a warm location, to see what per cent will germinate. At least twenty out of every twenty-five seeds should grow, or else there should be thirty-six or more quarts of seed per acre, instead of thirty-two, or fifty to fifty-five pounds instead of forty-four, which is the weight of hemp seed per bushel.

It is not easy to change the climate of any locality, but water-furrows at frequent intervals will allow the surplus winter moisture to run off, and the soil will be warmer; while it will be better still if deeply plowed in autumn and an abundance of decaying animal and vegetable matter turned under. A light soil, as a rule, is sweeter, warmer, and more congenial to plant growth than a hard soil. This also applies to the means of retaining a proper supply of moisture. A light soil with an abundance of humus will hold a much greater amount of moisture than if "packed" and hard.

If not covered by vetch or rye to be turned under in early spring, the ground should be plowed eight to ten inches deep, and if it has not been recently more deeply stirred the furrow should be

followed with a lifting subsoiler, the deeper the better. If, previous to plowing, the surface to the depth of four or five inches has been thoroughly pulverized with a disc harrow and then turned under, the subsoil will be in perfect condition for the deep searching of the roots of the plant. When so plowed and prepared in autumn, the only stirring necessary in the spring will be a thorough pulverization four to five inches deep by the disc, remembering that the thorough mechanical working of the soil adds as much as an ordinary application of manure. Of course the hemp plant will grow to some hight without these ideal conditions, but no plant better rewards all the extra labor and time in a perfect preparation of the soil. An acre of hemp twelve feet high will give a yield of 1,500 pounds of fiber, worth six to seven cents a pound, but if the same acre is made to grow a crop fifteen feet tall in a perfect manner the yield will be over 2,000 pounds of fiber, worth seven to eight cents a pound, a difference in favor of a perfect preparation of the soil of $25 to $35 per acre.

The preparation of the soil is the one particularly important thing. The seed is sown, one bushel of prime seed per acre broadcast, and preferably with a press drill, in which the shoes are not over five inches apart, and the springs and pressure so set that the seed will all be placed at an even depth of one to one and one-half inches. This insures an even germination, so that all plants start at the same time and continue an even hight until maturity. The drill is drawn by four light mules — the driver riding — and should cover twenty acres per day. This gives as good a stand as is at

present practicable, unless there be but half a bushel per acre sown at a time and the field be cross-sown with another half bushel. This insures each seed a definite amount of space in which to grow, not to be too thinly seeded nor overcrowded. After seeding a light fine-tooth harrow, drawn by two mules and covering twenty to twenty-five acres per day, may be run over the ground to create a mulch and prevent packing. If the surface soil is exceedingly light and dry a roller may take the place of the harrow. For a perfect result a light mulch of cotton hulls or fine hemp hurds, thrown by a rapidly revolving manure spreader, will be a great advantage.

South of latitude 35° hemp may be planted any month in the year. The growth will be slow in December and January above ground, but the tap-root will be taking a firmer hold in the warmer earth below, and the crop will be a decided improvement over one sown in March and April. The only thing to be considered in sowing seed in the warmer months is the probability of a want of sufficient moisture to germinate the seed before it is killed by the hot sun, and to guard against this the seed should be covered at least two inches deep and the light harrow run over the ground afterwards.

As hemp sown in the winter and early spring will be ready to harvest for fiber in June, preparation should be made to plant a succeeding crop of hemp if land is rich or manures are to be had, or a crop of cow-peas or other rapidly growing plant to furnish feed for stock and to improve the soil condition.

If planted early hemp is likely to get such a

start as to completely shade the ground and be less affected by any short periods of drouth. Where there is likelihood of heavy rains the ground should be bedded up by "back furrowing" in plowing, so that a water furrow can be left each thirty or forty feet, and these leading into ditches, so that surplus water may readily run off.

North of a mean temperature of 60° hemp is sown at the same time as spring grains, or earlier if the ground is in proper condition. In the latitude of New York city, Indianapolis and Omaha, hemp is sown April 1 to 15, according to the earliness of the season. Upon Staten Island, N. Y., hemp was sown for fiber March 24 and harvested June 24, 1899. A second crop was sown upon the same land July 1 and harvested October 10. The first crop was eleven feet tall, the second nine feet. Smyrna hemp, planted August 1, was seven to eight feet tall by November 1 and the seed ripening. The tendency of late-sown hemp is to a shorter growth and an earlier seeding. All these plantings were irrigated. One crop of American hemp is all that it is practicable to grow north of latitude 40°.

The surface of the field should be left as even and free from lumps or obstructions, weeds, roots, or anything which will interfere with the steady running of the cutting machine within an inch or two of the surface. Nothing can be done to the crop or the soil after the seed is sown. No weeding is ever required. Hemp is as sure a destroyer of weeds as a heavy broadcast seeding of cow-peas.

CHAPTER X

IRRIGATING THE HEMP FIELD

It is highly probable that three-fourths of the farm lands of the United States could successfully grow hemp to a hight of ten to fifteen feet, according to latitude and variety of hemp sown, giving a yield of 1,200 to 2,000 pounds, and a profit of $75 to $150 per acre, if there were a regular supply of moisture during the growing season. With the uncertainty attending the rainfall, however, it is only safe to plant hemp upon soils adapted to holding moisture, or of such a character and so located as to receive moisture from below by what is termed sub-irrigation. Even upon these lands the yield would generally be enough greater by irrigation to meet the entire expense of constructing an irrigation system, especially where the location is near a considerable stream of water.

In the hemp industry every idea of economy points to the employment of a considerable acreage, that all labor-saving appliances may be employed and machinery perfectly adapted to the performance of the work in an economical manner. If this be the case there will be machinery of a character to be directed to all departments of the work, and as the hemp hurds are of no other particular value than to furnish mulch, or to improve the character of the soil mechanically, they may be burned

as fuel to run the machinery. The hurds, or woody matter of the hemp, contains but a trifling amount of plant-food, the greater part of which may be returned to the soil in the ashes. These hemp hurds will supply all the fuel for running the machinery to handle 100 or 500 acres of hemp, and to allow of the diverting of steam to run steam pumps to supply all the water required in irrigation at a merely trifling expense.

The cost of an irrigation system for running the water upon the land in water furrows will be, a steam pump of sufficient capacity to raise 25,000 gallons of water an hour for ten hours a day,—without reservoirs—during periods of drouth, and for pipe four inches in diameter as may be required to convey the water to the higher parts of the hemp field. The manner of applying water where the supply is abundant will be seen by reference to Fig. 10, in which *a a* represents the main water furrow along the highest parts of the field and *b b* the lateral furrows running over the ground. All these water furrows should be parallel and the system always laid out at right angles to admit of the running of the drill in seeding and the mowing machine in cutting. The furrows should be about thirty to forty feet apart. The main furrow conducting the water to the other furrows will require to be deeper than the lateral furrows, which need not be deeper than the furrows left between lands at plowing. The amount of 25,000 gallons an hour is sufficient to water ten acres each ten hours. To do this the water furrows covering one or more acres are opened at the junction with the main furrow enough to let in the water in proper amount,

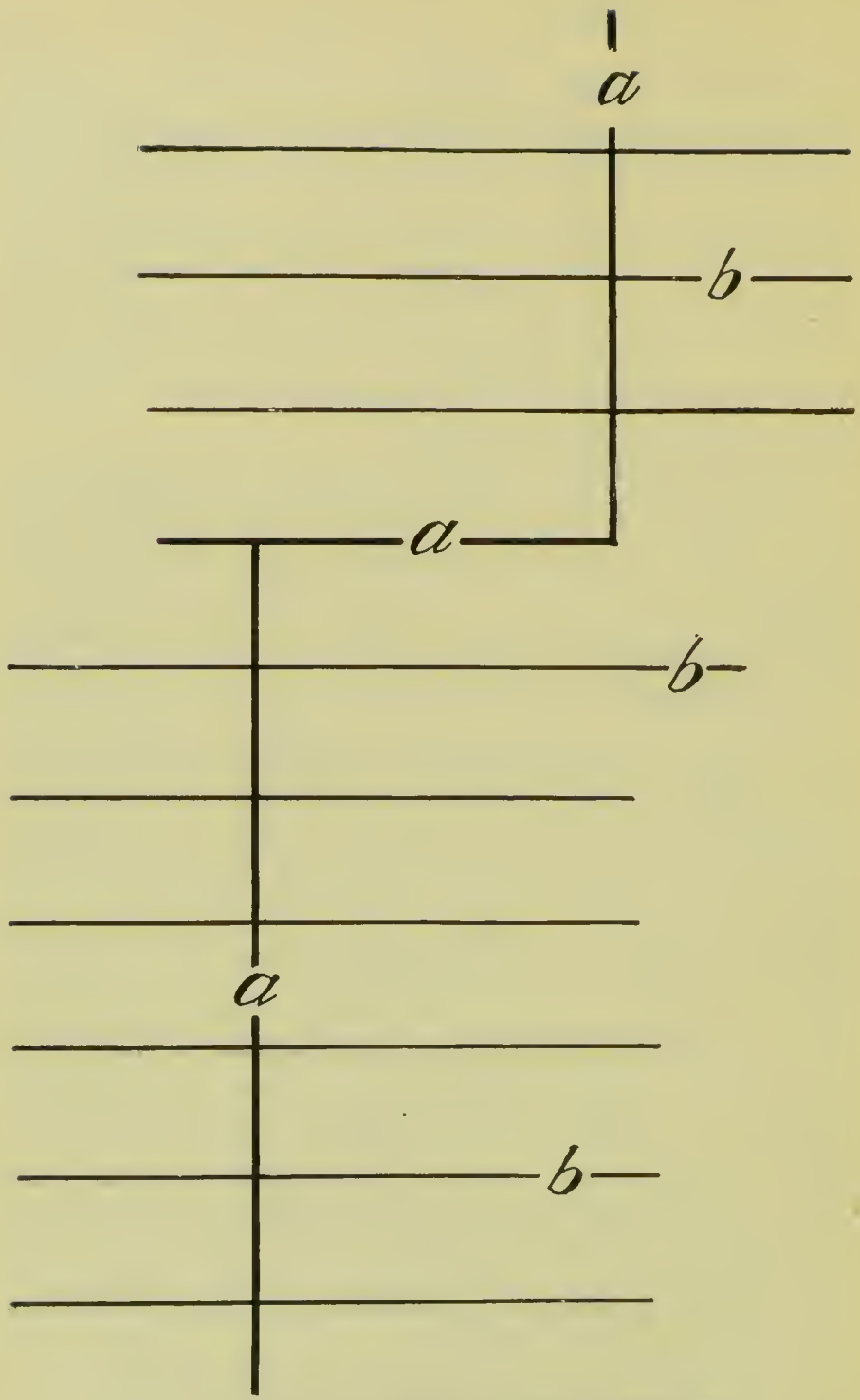

Fig. 10. Irrigating Hemp by Water Furrows.

while the others are closed by a shovelful of earth at the entrance. Where the soil is sufficiently saturated these furrows are closed and the water run to the next lot. In this manner one man can attend to the irrigation of ten acres each ten hours, and one hundred acres each ten days. The soil should not be left flooded nor over-saturated for more than a day or two, as would be the case were there a rainfall amounting to one inch per day. These water furrows should have openings and connections to a lower ditch, to facilitate drainage at times of excessive rainfall, while any basins or low places where water would collect should have openings.

Another and most satisfactory method of watering a field, large or small, level or hilly and uneven, and where the water supply is not as cheaply obtained, nor so abundant as to allow of its being thus wasted, has been perfected by the writer. This is to answer the objections of expense and the difficulties attending the irrigating of fields of uneven surface, and also the objection that a thorough saturation of the soil has the effect to dilute the soluble plant-food, wash a considerable part of it away, and also to smother for a time or drown the plants and retard their rapid growth while the water supply is too large, and to allow of the soil becoming run together, and afterwards the period of drying out of the soil giving an irregular supply of plant-foods. The objection is also made that water should be applied to the foliage as well as to the roots, and that it should be done at night instead of during the sunshine, especially at seasons of high temperature.

This new system which the writer has had in

experimental practice for several seasons, consists in erecting tanks, or constructing reservoirs to give a considerable pressure, and then laying pipes upon or under the ground below depths of plowing, which carry the water to the fields as desired. Openings are provided at points about one hundred feet apart each way, and standing pipes with spray-nozzles applied, and the water turned into the pipes.

The effect of the pressure is to force the water out upon the atmosphere and allow it to drift or be carried by the wind to a very considerable distance, thus moistening the foliage of the plants. As the work is done at night, and may be regulated in flow at will, there are none of the objections to the system brought against the saturation of the soil. In this system small pipes may be laid to any part of a field, without reference to the unevenness of the surface.

These standing sprays can be made to carry a large or small supply as desired. An inch pipe under pressure will carry 50,000 gallons a day from the reservoir and supply ten spray pipes upon ten acres with 2,500 gallons each for each twelve hours, six P. M. to six A. M.

In the artificial raining which is produced by this method the atmosphere is rendered humid during the night, the moisture is given in a form to be absorbed and held, none running off and none percolating below the reach of the plant-roots. The expense and the amount of water supply are readily within reach of every farmer, and the moisture may be given to the higher lands, where the soil conditions are of the character most needing the moisture in controllable quantities.

CHAPTER XI

HARVESTING HEMP FOR FIBER

THE young hemp plant should begin to come up in four to six days after planting, according to temperature and moisture. The growth above ground will be slow for five to ten days, more especially in cool weather, but the roots of the plant will be making progress downwards, its tap-root searching deeply for a foundation and food and moisture supply for a tall, vigorous plant. A growth of thirty to thirty-six inches, even under favorable conditions, is all that may be expected for the first thirty days. At that time the plant will have become firmly rooted, a great number of feeders will have become established in all directions, and, if the soil be fertile and mechanically favorable, the plant will make a growth of two to four inches per day, according to warmth, for the next thirty days for the Smyrna and American varieties, up to a growth of thirteen to fifteen feet in eighty to ninety days, when the plants will then begin to blossom, and the Smyrna variety be ready to harvest, the American variety, some two feet taller, following in about ten days. The China variety is sufficiently distinct and susceptible to the influences of fertilizing elements that, with an abundance of moisture and fertility in the soil, it will be found growing about an inch a day faster than the other kinds, and to have attained a hight

of eighteen to twenty feet. The inconvenience of handling the taller-growing crops often suggests that the American variety, not growing quite as tall and maturing ten days earlier, may be preferable where the conditions favor the growth of two crops each season.

When in full blossom the hemp is in best condition for fiber. The oil is still in the bark, while it has become sufficiently mature to stand the action of the chemical changes by the putrefactive fermentation in warm, soft water, and the harsh methods of crushing and breaking the hemp stalks to separate the wood from the fibrous material. If a soft fiber is desired, such as is highly susceptible of a subdivision into fine *fibrillæ* for laces and lawn tissues, the hemp may be harvested some ten days earlier, or at the first general appearance of the indications of bloom upon the male stalks. When delayed until the male stalk dies and seed begins to ripen, the fiber becomes drier, grows harder, the stalks begin to lose their natural form, and the fiber becomes "dead."

The hemp is cut close to the ground by a self-raking combined reaper and mowing machine, preferably the old style heavy, substantially made Champion, cutting four to four and one-half feet wide, rear cut No. 4, and using but two of the four rakes used in cutting grain. This machine does not bind the hemp, but lays it off at the side in convenient armful size. This work is rather severe, and the more substantially made kinds of old-style machines are best. With three heavy, quick-stepping mules or farm horses, and a driver who understands his work, an average of ten acres per day may be cut.

A helper, or man with a hook four to six inches long in the end of a fork stale, attends in the field, and if several machines are at work several helpers will be required, to pull out any particularly large or "volunteer" stalks, which are too coarse to be easily cut, and to assist the machines in cases of accident or difficulty from the tangling of the cut stalks by high winds.*

While at work each machine will require four sharp sickles per day: one at commencing work in the morning, another by ten o'clock, the next at noon, and another change by three o'clock, which will keep one man employed at the grindstone and at replacing and repairing broken sections, etc.

After lying two to four days the armfuls of hemp are turned by thrusting a fork stale close under them near the tops and throwing them endwise over the butts, where they are spread if desired and let to dry for two to four days longer, and then tied with rope yarns from old sisal or Manila rope, cut of the right length and ready looped at one end, a supply of which the binder carries under

*Volunteer hemp is that growing from seeds which have been scattered in handling previous crops, and that has lain on the ground all winter. From its lying on the ground it is ready and germinates quicker upon the appearance of warm weather, its roots get more firmly fixed, and it grows more rapidly, attaining a hight of two to four feet above the rest of the hemp, and may be double the diameter. From this suggestive fact experiments have been made in planting hemp in December, but the occurrence of warm spells sufficient to germinate the seed before severe freezes are over renders it impracticable north of a latitude of 35°. All wild hemp is volunteer hemp, and what germinates in cold latitudes before winter is killed by freezing, but considerable of the seed remains upon the stalks until freezing weather, while some falls in cool, protected, or dry spots, or is saved by the natural mulch of stalks, leaves and foliage, so that the wild plant thrives to the extreme north. The experiments in fall and winter planting of hemp have not been carried on to an extent to fully determine its advantages or difficulties. In Florida hemp is best sown in November or December, as are winter grains.

his suspender during the work. Others follow the binders, bringing the sheaves together in shocks or stacks, where they remain a few days longer to sufficiently "cure" not to mould in stacks or mow, when the hemp is put under cover or stacked. If stacked, it is in a circle around a pole and upon poles or planks to keep the hemp from contact with the ground, tops inwards and lapping a little for elevation and convenience in thatching to shed rain. A convenient shed is made by setting posts, fifteen to twenty feet long, firmly in the ground and placing a roof upon them. This kind of shed may have posts each ten feet in rows, and another row twenty-five to thirty feet away, parallel and continued to any length as the amount of stalk of hemp require. When housed under these sheds it is placed butts outwards. In this way or in stacks, carefully covered, the hemp will remain uninjured for a couple of years, if necessary.

After stacking or putting under cover, the hemp should be let remain thus a few weeks at least, to ripen, mellow and cure, the fibrous material to gather "nature" and maturity, and above all "quality," before it is retted and handled to obtain the fiber.*

*This word "quality," and the other "nature," are words common to the industry, but, like the word "skin" in the Irish and Belgian flax manipulation, difficult to describe or define. "Skin" is the glossy, lustrous appearance of a fiber containing great "nature" and "quality," and the added characteristics of "life," as opposed to a dead fiber of a hard, "harsky," woolly or towy character. Silk has quality, life, skin, and above all nature, it is alive and highly susceptible to the spinner's art. Nature and quality are to some extent synonymous: they are what give character to the material, as the difference between iron and steel, gold and brass, the characteristics of fine qualities in fabrics,—in fact, in anything,—but are best understood from a long experience in handling and manipulating. In the fine art of an exact scientific culture of hemp the purpose is to develop this silky character, and the work continues in all stages of handling. It is not the plant so much as the skill in manipulation which produces the high character.

CHAPTER XII

RETTING AND PREPARING THE HEMP FIBER

Next in importance to a careful preparation of the soil and the planting of the hemp seed, is the work of recovering the fiber and of preparing it in a perfect condition to enter into the various products of manufacture. The valuable part of the hemp plant, grown for fiber, is in the bark or covering of the hemp stalk. This, in the fine art culture, has become a tall, slender stalk, bearing no branches until near the top, and covered with a ripe, mellow, strong and flexible cortex of fibrous material, only waiting the skilful cleansing from the gummy matters surrounding and uniting them together to present a quantity of soft, white silky fiber, almost rivaling silk in luster and in fine spinning quality. This cortex or bark of fibrous material is composed of an outer covering of thin film, and then a fleshy mass of chlorophyl and resinous gum holding a great number of infinitesimal cellular tissues, the surroundings of which are not soluble in water, even by hours of boiling, but soluble in the natural destruction of a putrefactive fermentation in soft water, by steeping from five to ten days, according to the temperature, and also in alkaline and neutral saponaceous solvents in from three to five days when cold, and in twenty-four hours when hot, and in two to three hours by boiling.

The effect of the fermentation is to generate an acid which corrodes and burns the fineness of the fibers to some extent, hence the great number of efforts to furnish a solvent harmless in its effects upon the fibers, and yet of a character to dissolve the gummy matters.

In the earlier part of this work the statement has been made that the cost of spinning the hemp fiber was much greater than that of spinning cotton or wool, because of a want of suppleness or flexibility resulting from the imperfect cleansing of the fibers from the resinous gum with which they are surrounded. When perfectly purified and prepared, however, the fibers of the hemp plant are as soft, fine and flexible as those of any other plant. This imperfect cleansing of the fibers is the result of the imperfect processes of retting and preparing them, as chemistry has not, as yet, solved the problem of furnishing a perfect dissolution of the gummy matters, which shall at the same time be rapid and harmless to the fibers and economical in practice. When this is accomplished there are many reasons why the hemp industry will be the greatest one for the production of fine serviceable fabrics.

When the hemp stalks are crushed and broken and the woody matters separated from the bark, the bark holds some 20 to 25 per cent of foreign matters. Raw silk holds some 18 to 25 per cent, and wool something more. The cleansing of all these fibers have special processes which have been adapted to them, but which are steadily being improved, but all have many features in common. Wool is the hardest to purify, requiring not only long boiling in neutral soapy solutions, but a considerable amount

of scrubbing and "scouring" to perfectly cleanse and prepare it for fine spinning.

The coating or crusting matters upon raw silk resemble glue to such an extent that they are given the name of "silk glue," or sericin. To fully remove this glue the skeins of silk are carefully tied to prevent being tangled, placed in canvas bags and tied to prevent the mingling of any foreign matters, and placed in wooden tanks of a size to hold about 100 pounds of silk and still allow of the free circulation of the liquors around it. These tanks have false bottoms, perforated, and under which are copper coils in which steam is turned to boil the liquor. The boiling liquor is composed of pure soft water, in which there is no lime nor mineral matters in solution, and in which about 25 per cent of the weight of the silk of fine neutral soap, free from resin or other impurities, is dissolved. After the liquor is prepared the hemp canvas bags of silk are placed in them and made to remain under the solution, the steam turned in and the silk boiled for two to three hours, according to the character and variety of the raw silk, and the purposes for which the fiber is to be used, coarse or fine, hard or soft. Often silk is made to take up an additional amount of gummy sericin to give weight to the product. Another process is to first boil the silk for an hour and then remove it to another tank of fresh solution, to be perfectly cleansed. After boiling, the silk is rinsed in warm, soft water to remove the silk glue when completely softened. The first boiling of silk in a fresh solution is not as good as the second after a portion of the sericin be-

eomes saponified with the soap. If the boiling off of silk and the scouring of wool has not been sufficient to perfeetly cleanse the fibers before spinning, the yarns or fabries are subjected to a further purification by boiling previous to the final "finishing" and "dressing."

This indieates the line of practiee for preparing the fibers from hemp. Not the same glue or gum exists in both animal and vegetable fibers, nor the same acids, but the expert chemist wants no more interesting task than to determine the exact relation and eomposition and the solvent required for the peeuliarly existing constituents of either, and when he shall have given hemp the exact study which all the other fiber and textile industries have reeeived, there is no question of the final results. Hemp is the best adapted by nature to respond to the work of the chemist and textile inventor, and the most susceptible of fine manipulation, and from its simplicity in cultivation and wide adaptation to soil and elimate offers the most interesting base upon whieh to build.

The proeesses of retting hemp have thus far largely been the same primitive praetiees which have eome down from the middle or dark ages. Not even the lost arts of hemp and linen practiced by the aneient Egyptians have been reeovered. They produeed a eanvas and a linen of a eharaeter not yet equaled by modern methods. The methods of retting were naturally such as must be practiced in all industrial matters where eonfined to hand labor, and the small aereage of an unintelligent people without the knowledge or the means to undertake experiments or the research for improved

processes, or for labor saving appliances and exact chemical methods. These are, however, slowly giving way to better practices, a better intelligence, and a more exact knowledge of the nature and requirements of this king of fiber-bearing plants.

As the process of cleansing wool is called scouring, and that of silk boiling off, so that of hemp is called retting, macerating, steeping, or watering. The origin of "retting," or "rotting," now most commonly used, can only be referred to the old practice of spreading the hemp upon the ground to become rotten from the action of the dews and rains and heat of the atmosphere, and to become decayed and the gummy matters sufficiently destroyed to admit the bark to be pulled off from the stalk. The term retting seems to have been applied originally to the dew retting practice, which has been generally superseded by macerating or steeping in stagnant or running water. The Italian term is *macerare* or *macerato*, from macerate, to steep, while the French is *roui* and *rouissage*, from *arrosage* and *roscidus*, bedewed. Added to the word *rouissage* in French, we have *routoir* and *rutoir*, a steeping pool or retting tank. German *stippen*, to steep or macerate.

The general practice is to place the hemp stalks in sheaves in a wooden crate of such size as can be handled with means at command, and slide them down tramways into the river, and then anchor the crates and pile stone upon them to sink them to a level with the surface of the water. Another practice is to pile the hemp stalks upon the bottom of artificially constructed retting pits (see Figs. 4 and 5), and either weighting with stones or by cross-

bars held under firmly fixed uprights. When it is found that the bark will readily slip from the woody stalk, in from eight to twelve days, the hemp is taken out and dried by spreading upon the ground, or separating the sheaves at the butts and standing them up. Another practice is to place the hemp in the water for four to six days, and then remove and dry it, and again return it to the retting pit. This gives a more even result, with less injury to the fiber.

In this manner the finest Italian hemps are produced. In France it is the practice to partly rot the hemp in the water, and after drying the stalks and breaking them to remove the hurds, boil off the fiber, as is done with silk. After retting in water, as described above, and drying the hemp stalks, they are run through a break consisting of several sets of fluted rollers, and the fiber freed from the hurds by shaking (see Fig. 11).

Added to these older methods are many modifications, both chemical and mechanical, and mixed, while the encyclopedias are burdened with accounts of patented processes for quickly doing the work, and many of the manufacturers have their own secret methods of improving or boiling off the fiber before spinning. Although the work is by no means complete, much light has been thrown upon the subject of fibers, their nature, composition and requirements of culture and preparation, as well as the adaptation and improvement of manufacturing machinery and appliances. It may also interest the reader to learn that the U. S. Department of Agriculture has undertaken a complete investigation of the subject of the hemp-fibers, from which we may hope definite results may soon be derived.

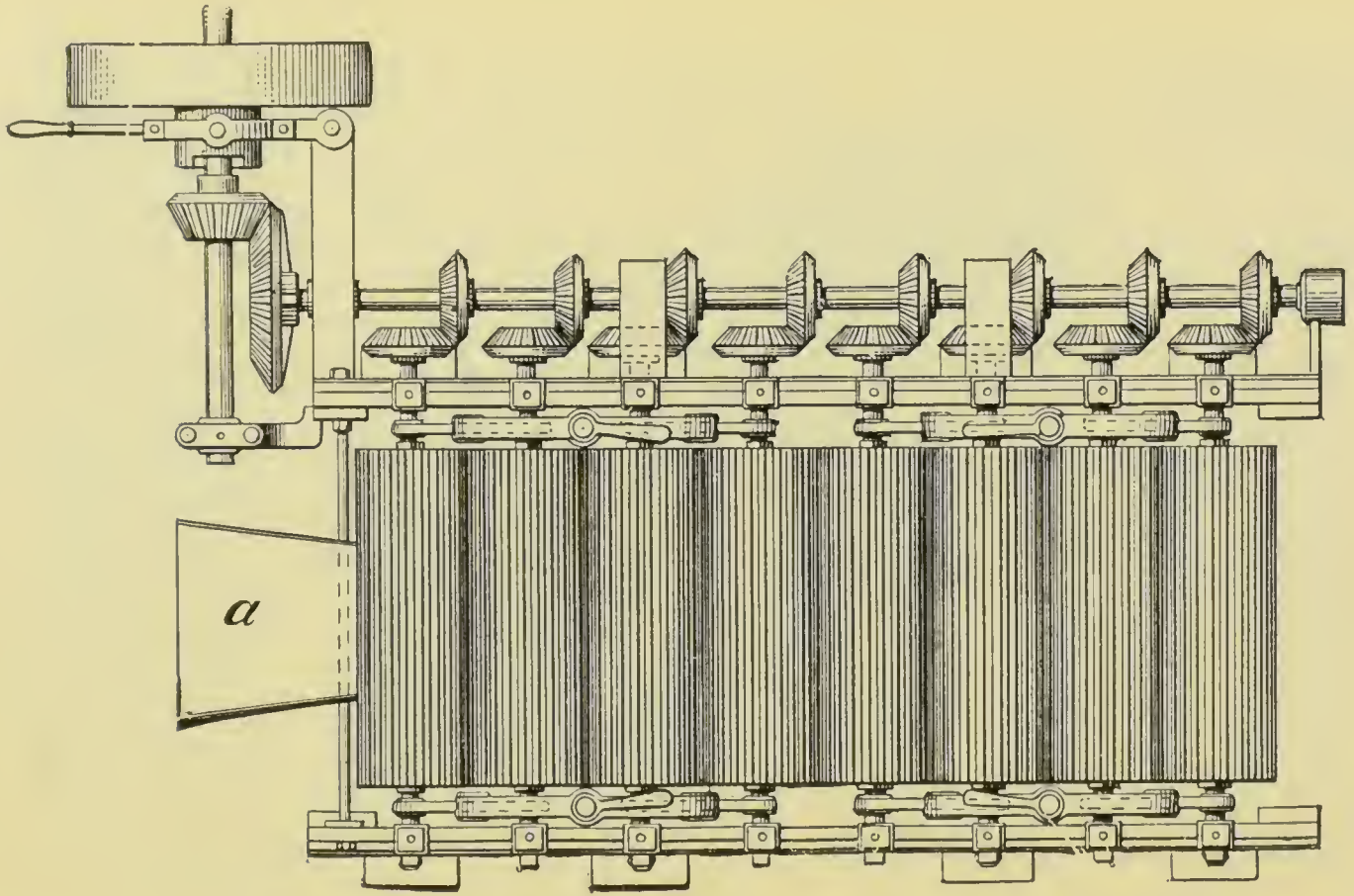

FIG. 11. HEMP BREAKING MACHINE. Showing style of gearing. *a*. Feed table.

There are three methods of retting hemp practicable where hemp is grown upon a large scale in the United States. If not grown upon a scale of at least three to five hundred acres by one planter, there should be arrangements for uniting several smaller growers, or that the hemp grown upon a smaller scale should be disposed of to the middle man prepared to ret the hemp and prepare the fiber and properly classify it. There is little economy in the small acreage system, as with cotton raising or beet sugar growing, where the working up is done by others. If there is sufficient profit in raising hemp with a yield of three to five tons of hemp straw or stalks per acre, and disposing of them to the middle man or manufacturer of fibers at $5 to $6 per ton, then it may be so done; but it is a division of profits against the farmer, as he loses all fertilizing matters where the hemp stalks are carted from the farm.

The first method is the ordinary water retting. For this method a system of square wooden tanks, as shown in Fig. 12, is constructed of a size and of a number to correspond to the scale upon which the work is to be carried on. To ret the hemp in the rivers is out of the question, from a point of sanitary consideration and also from that of economy. To handle 500 acres of hemp, growing fifteen feet high, requires preparations to handle 2,500 tons of hemp stalks. If the work of retting goes on continuously from March to November out-of-doors, it will require the handling of at least ten tons of stalks per day. If the work is done by the same gangs of laborers as the plowing and planting and harvesting, and there is an interruption

of a month in March and another in July, the capacity should be sufficient to handle fifteen or twenty tons per day,—that is, of emptying tanks holding twenty tons and putting the stalks out to dry and refilling the tanks, and also taking in twenty tons of dried retted stalks and putting them

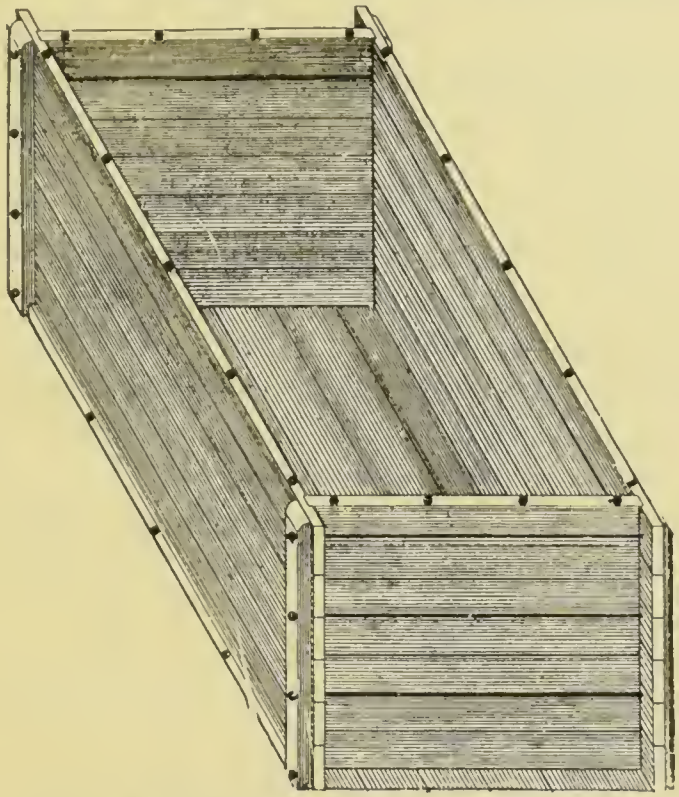

Fig. 12. Single Tank for Retting Hemp.

under cover to be broken at a later day. The breaking can be done from December to March. Upon a hemp ranch of 1,000 to 5,000 acres, in a latitude of 35°, the work of preparing the soil, sowing and harvesting the hemp, retting and breaking and shipping may go on continuously, several gangs of laborers being employed, each under its department superintendent, for the purpose.

To handle twenty tons of hemp stalks per day will require eight retting tanks 8 x 15 feet and five to six feet deep. These should be situated upon the more elevated portions of the ranch at one point, or in two places some distance apart, or the tanks may be so constructed upon timbers as to be moved from place to place once a year as the ground around the tanks becomes fertilized by water and refuse from handling the hemp. The steep-water and the foliage and waste from the hemp are high in fertilizing elements.

To construct a system of four tanks that will be firm and substantial and yet adapted to removal once a year as desired, four timbers 8 x 8 inches and thirty-six feet long are placed level upon the ground, five feet apart and parallel to each other. Upon these timbers heavy planks one or two feet wide, two and one-half inches thick, and fifteen feet long are jointed, pressed closely together and firmly spiked down. At the front edge planks are set up edgewise and spiked to the first one, and uprights six feet long of 2 x 6 pieces are spiked to the sides of the timbers below and against which the sides of the tanks are spiked. After a flooring eight feet wide is laid, other planks are set up and spiked to the last plank laid down. The work is thus continued until four tanks eight feet wide are provided for. The divisions of the tanks are held in place by other uprights and the ends fitted in, or upon the outside, uprights being set in the corners of the tanks to spike to. This gives four substantial tanks holding three tons of hemp stalks each, when closely packed, the first having the larger butts all one way, and the next larger the

other. When so filled the stalks are held down firmly by cross-pieces and the tanks are filled with water. Tanks of smaller size, and only one or two in a system, can be used if preferred, and may be located in separate places, as desired, to receive and dispose of a water supply, and for convenience in standing out the hemp sheaves, or spreading them to dry. In six to ten days, according to temperature, the bark of the hemp stalks will be found to readily slip off when the stalks are broken in the hands, and the hemp should then be taken from the tanks or vats and dried and put under cover to be broken, shaken from the woody matter and baled. The only limit to number of tanks and size is the supply of water.

The above method will produce a prime cordage hemp for use where a strong, serviceable fiber is desired. Another process is to take the hemp stalks from the retting vats in five days and dry them by standing out or spreading, and again returning them to the vats for five to eight days longer. This produces a fiber corresponding to the best Italian hemps now found in market, and is adapted for fine cordage, coarse threads, carpet warps, canvas and similar products.

Another method is to place false end pieces across the tanks some two inches from each end of the retting tanks and reaching down to within two to four inches of the bottom. A half-inch stream of water is let flow into the tank upon the top. This carries all impurities downwards and out under the ends of the false ends and up and out over the real end, made an inch the lowest, and thus maintains a circulation of water which

produces a fiber of much lighter color, especially if the water used is slightly "hard" and impregnated with lime.

After the hemp is retted in water in the tanks for five days it may be taken out, dried and broken, and will furnish an exceedingly strong fiber for many uses. After water retting and drying the stalks, they are put under cover to further ripen and mellow. In all the work there should be some six weeks between the time of harvesting the hemp before it is retted, and the same length of time between the retting and the breaking, so that there will of necessity have to be a storage room for at least a supply for the work of six weeks.

In retting, the tanks are emptied one or more each day, the contents put out to dry and again filled, so the work goes on steadily. Rain and snow and frosts do not injure the hemp after it is retted; in fact, the washing from a rain is an advantage, while a sharp frost serves to disintegrate the fibers.

Another process is to first break the hemp stalks by passing them through a breaking machine consisting of ten to twenty sets of heavy fluted rollers run by bevel or miter gears and held together by springs upon the top. (See Fig. 11.) When so passed through these heavy crushing rollers the "shives," "boon," "hurds," or woody matter, is thoroughly broken up and shaken out. As it requires five to six tons of hemp stalks to yield a ton of fiber, it can readily be seen that first breaking the hemp and disposing of four-fifths of the weight and bulk leaves a much less amount to be handled and very much saves labor in the work;

besides, a tank holding five tons of stalks would hold all the fiber from twenty-five tons of stalks. If the hemp is first broken the retting tanks may be of much less size, while it is much easier to handle the fiber alone than the stalks, and in retting the water attacks the fiber evenly on all sides alike, whereas with the stalks the water only comes in contact with the outside of the fiber. In drying the fiber after it is so retted twenty-five tons may be hanged upon an acre of ground if placed upon bars, upon horses, or other frames, for support. After drying in some four days, the fiber is put under cover to be again run through the breaking machine, and is in much finer condition for market. In all this work, if the retting tanks are filled with one pound of potash lye to each one hundred pounds of hemp stalks or fiber, the retting will be done in four days instead of eight. When this is done with the fiber alone, the fiber is afterwards put into a solution of muriatic acid, one pound to one hundred gallons of water, and again rinsed in water.

To facilitate the work of handling the fiber, it may be put into long wooden or galvanized iron crates or baskets, holding two hundred pounds each, and placed in the tanks, and when retted hoisted out by a traveling pulley overhead and immersed in other tanks. In packing these baskets or crates a cross-piece is placed at the bottom of each, with upright fingers two and a half to three inches apart, between which the handfuls of fiber are placed, and cross-pieces laid on and again handfuls of fiber, that they may be more readily separated in removing them.

Instead of potash, some two to four pounds of

neutral soap, free from resin, may be used and the hemp fiber retted without the use of the acid bath, the fiber being rinsed in soft water. Also the retting will be done in two to three days if the weather is warm, and there will be but little of the bad odor attending ordinary water retting. If this solution of soap and water is made hot, the retting will be done in twelve hours. If perforated steam pipes are inserted at the bottom of the tanks or vats and live steam turned in for boiling, the retting will be complete in one to three hours, according to strength of solution used and the degree of fineness desired. If the hemp which has previously been water retted and broken is boiled for half an hour in such a saponaceous solution a nearly perfect fiber results. After boiling and rinsing and drying, and the hemp has lain four to six weeks to mellow, ripen and gain nature and quality, it is run through the breaking machine, softened and baled, as is done with cotton.

CHAPTER XIII

MACHINERY FOR HANDLING HEMP

Before the hemp stalks are retted they may be run through a hemp-breaking machine (see Fig. 11), consisting of ten to twenty or more sets of cast-iron rollers fluted lengthwise, some six inches in diameter, and having fifteen or seventeen flutes to each roller for the first three sets, twenty-one or twenty-three for the next five sets, and twenty-seven to thirty-one for the rest. If but ten sets of rollers are used, it will be necessary to pass the hemp stalks in small handfuls twice through the machine; with twenty sets twice the amount can be broken. This machine, which can be built upon an oak frame of four- by eight-inch stuff, and the rollers, cast by any iron founder, can be set up by ordinary mechanics and run by common laborers under the direction of a superintendent. The expense is $175 to $300, according to how close the builder attends to the work.

In a ranch of five hundred acres the use of two of these breaking machines would be required, and the capacity of unretted straw five tons a day each and of retted straw seven tons, requiring ten horse power and the service of four men to each machine. The hurds from the hemp furnish

all the fuel, and are moved by endless carrier to such points as desired, and are fed under the boiler with a large door by a large hand scoop made of seven or eight tines two and one-half feet long. The ashes from this fuel furnish some 10 to 12 per cent of potash and 3 to 5 per cent of phosphoric acid, and will furnish all the potash for making soap and for softening the water and retting the hemp, besides a large amount of fertilizing element directly to the soil. Used to soften water and to ret hemp, the fertilizers should afterwards go to the soil. The cost of the engine and boiler will depend largely upon ideas of the purchaser. A second-hand forty horse-power engine and boiler in first-class order was put up complete for $375. But, as with a cotton ginning outfit, the style and surroundings materially differ with different men.

Beyond this breaking machinery there is but little required in the farmer's manipulation of hemp. After the hemp is retted in the special way to suit special demands of x, xx and xxx hemp, it is often found that if the ends of the hemp fiber are combed or straightened out and smoothed down, or partly dressed by the action of revolving teeth, the manufacturer is willing to pay one to two and sometimes five cents a pound more for it, according to the skill in "handling" the fiber. To meet this demand, a revolving cylinder, some five feet in diameter and four feet wide, is made by fastening bars of wood across two iron wheels and passing a shaft through it, as seen in Fig. 13. In the cross bars are spikes protruding some two inches and preferably sloping backwards, that their

action may be gentle upon the handfuls of fiber held up to them or thrown upon them, as shown in the illustration.

This combing- or scutching-machine does all the working which the hemp fiber requires after being softened in the breaking machine. Nor

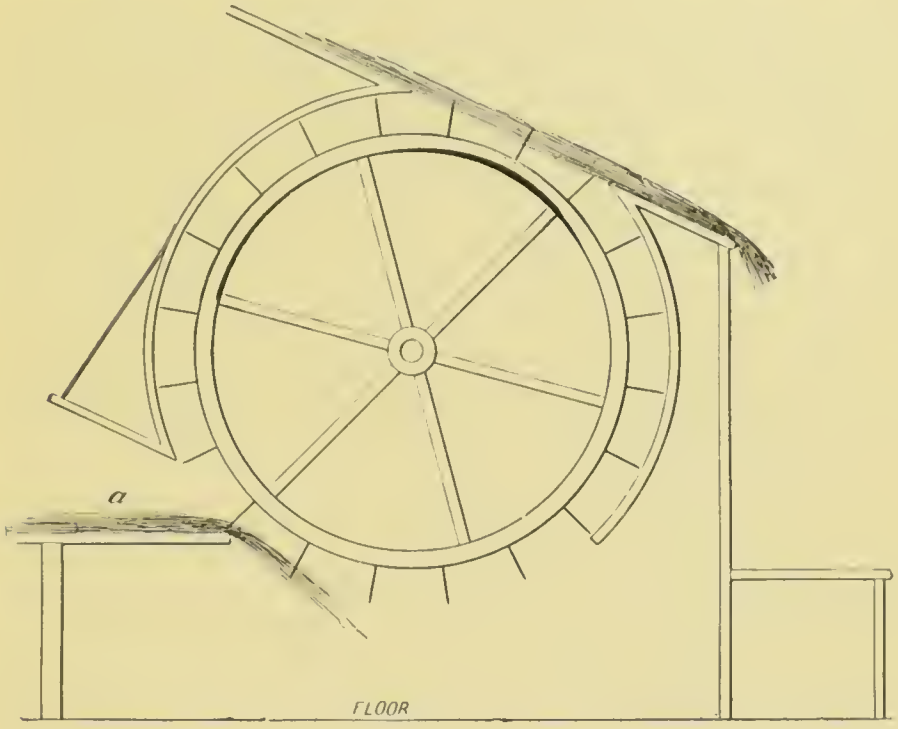

FIG. 13. HEMP SCUTCH OR COMBING MACHINE.
a. Handful of Hemp.

should the work be made severe upon the hemp, as a good deal of tangled fiber or tow would thus be made, which is of less value than the straight fibers or line.

As with other products and practices upon the farm, there is an abundant reward for fine work, while but a poor recompense attends the careless

and unpainstaking. In proportion as the farmer studies the nature and wants of his soil, his crops and his animals, and becomes skilful in the manipulation, is there the permanent probability of profit, which is the aim of all pursuits.

L'ENVOY

As this little work is leaving the press we have the definite announcement from the Division of Botany of the United States Department of Agriculture, that it has "determined to import experimental quantities of superior varieties of hemp seed from China, Japan and the Mediterranean region for experiments with their cultivation in the United States. It is planned to carry on these experiments at various points from Washington southward through the Atlantic states to Florida." We thus have the assurance that the unsettled questions pertaining to the best methods of cultivation and the most profitable management of hemp will be determined, and definite conclusions presented to the American people, as the intelligent basis for the employment of labor and capital in successfully developing in America the last of the great leading industries with which the old world has so long been conversant, but which has not yet obtained prosperous foothold in the United States. There is no question that when the inventive genius, comprehension and energies of the American people become interested, another grand source of profitable employment and prosperity will be established.

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